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Woody Plant Species with High Nutritional Value, Northeastern Mexico

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Abstract

The study site was located at the Experimental Field of the Forest Science School, Universidad Autonomy de Nuevo Leon (24°47′N; 99°32′ W, 350 m asl), 8 km south of Linares county, Mexico. The present study has been undertaken to determine the variability in leaf nutrient contents (macroand micro) of 37 woody species in northeastern Mexico, which revealed the presence of large variability among the macro and micro-nutrient contents. By quintuplicate, mature leaf sample tissues were collected from each plant species and placed to dry on newspaper for a week. Leaves were removed from twigs and were passed through a mesh of 1.0×1.0 mm^2 using a mill Thomas Wiley. Subsequently, they were dried for three days at 65 °C in an oven to remove moisture from the sample and later these were placed in desiccators. Among these 37 woody species of northeastern Mexico, the species containing highest P and Mg are *Croton suaveolens* (2.43 mg g^{-1} dry weight) and *Ehretia anacua* (9.45 mg g^{-1} dry weight), respectively, whereas *Cordia boissieri* recorded maximum K as 45.58 mg g^{-1} dry weight, Cu and Fe (30.71 and Fe 280.55 µg g^{-1} dry weight, respectively). *Acacia schaffneri* has 4.32% N (maximum) and *Forestiera angustifolia* 49.47% N. The species with highest C/N are *Sargentia greggii* 23.13 and Zn *Salix lasiolepis* (144.86 µg g^{-1} dry weight). The species selected for the highest macro- and micro-nutrients may be utilized for confirming their physiological efficiency and probable better growth and productivity.

Keywords: Macro and micronutrients, woody plants, forage value, Mexico

1. Introduction

The shrubs and trees of Tamaulipan thornscrub in the semiarid regions of northeastern Mexico are of great economic importance for various uses such as timber for furniture, fences, firewood and sources of forage for wild grazing animals for possessing macro and micronutrients required by livestock and ruminants (Ramirez Lozano, 2014). Leaves contribute greatly in plant growth and productivity for photosynthesis and nutrient contents. In northeastern Mexico, there exists great diversity among plant species in growth forms, leaf size, leaf shape and canopy management (Reid et al., 1990; McMurtry et al., 1996; Northup et al., 1996). In addition, there exist some general relationships across wide range of species in leaf traits which contribute to determine the carbon fixation strategy among species. The outer canopy leaves and its specific leaf area tends to be correlated with leaf nitrogen per unit dry mass, photosynthesis and dark respiration sites (Wright et al., 2001). Leaves contain various macro-and micro-nutrients, which are absorbed by roots from soil horizons and are required for plant growth and development and as source of nutrients for grazing animals in the forest ecosystem. A large variation among species with leaf traits contribute to nutrient conservation and permit short term growth. Species having nutrient conservation have long life span, high leaf mass per area, low nutrient concentrations and low photosynthetic capacity (Reich et al., 1997). The availability of nutrients in leaves is essential for efficient plant function. Chapin (1980) reviewed the nature of crop responses to nutrient stress and compare these responses to those of species that evolved under more natural conditions. He gave emphasis on nutritional status of nitrogen and phosphorus because these elements commonly limit plant growth. Leaf nutrient content depends on the availability of nutrients present in the soil habitat. Nutrient-poor habitats tend to be dominated species by nutrient-conserving species, while fertile habitats tend to be dominated by species with higher short-term productivity per leaf mass (Chapin et al., 1990). Within a given habitat, species with a range of leaf traits can coexist (Reich et al., 1999). With the age of leaves, nutrient resorption occurs when nutrients are withdrawn from leaves prior to abscission and translocated to developing tissues (leaves, fruits, and seeds). Resorption occur throughout a leaf's life particularly when the leaves are shaded (Ackerly and Bazzaz, 1995; Hikosaka et al., 1996). A major phase of resorption occurs shortly before leaf abscission, which is a highly ordered process of leaf senescence occurring in most species (Nooden, 1988). They are recycled via resorption around 50% of leaf N and P (Aerts, 1996). It is suggested that the presence of active nutrient sinks has control over resorption (Negi and Singh, 1993). Rengel and Marschner (2005) studied nutrient availability and management in the rhizophere showing genotypic differences. Plants exposed to nutrient deficiency activate a range of mechanism that led to increased nutrient availability in the rhizophere compared with bulk soil. Plant may change their root morphology, increase affinity of nutrient transporters in the plasmamembrane and exude organic compounds (carboxylates, phenolics, carbohydrates, enzymes etc.). Chemical changes in the rhizophere lead to altered abundance and composition of microbial communities. Understanding the role of plant-microbe-soil interaction governing the nutrient availability will enhance environmental sustainability. Wright et al. (2001) developed a strategy shifts in leaf physiology, structure and nutrient content between species of high- and low-rainfall and high-and low-nutrient habitats. Most plants withdraw nutrients from leaves with advance in age. Plants contain nutrients useful for ruminants and wild animals in which direction research has been undertaken. Lukhele and Ryssen (2003) undertook a study on chemical composition and potential value of subtropical tree species of *Combretum* in southern Africa for ruminants. It was concluded that the foliage tested would not be a suitable resource of N to supplement protein deficiencies in low quality herbage. The present study was undertaken to evaluate few macro and micro-nutrients of 37 woody species of the Tamaulipan thornscrub and select species with high nutritional value for grazing animals.

2. Materials and Methods

2.1. Study site

The study site was located at the Experimental Field of the Forest Science School, Universidad Autonomy de Nuevo Leon (24°47′ N; 99°32′ W, 350 m asl), 8 km south of Linares county. The climate is subtropical and semiarid with warm summer. Monthly mean air temperature ranges from 14.7 °C in January to 22.3 °C in August, although daily high temperatures of 45 °C are common during summer. Average total annual precipitation ranges from 600 to 805 mm with a bimodal distribution. The peak rainfall months are May, June and September (Rodriguez et al., 2004). The dominant soils are deep, dark-gray, lime-gray, lime-clay Vertisols, with montmorillonite, which shrink and swell noticeably in response to changes in soil moisture content.

2.2. Plant material

The species were selected on the basis of ecological and nutritional value for livestock and wild ruminant animals (Rodriguez et al., 2010; Gomez et al., 2012) and multiple uses of shrubs in north-eastern Mexico (Reid et al., 1990). The species included in present study are shown in Table 1. Thirty-seven woody species belonging to 16 families having both simple and compound leaves were studied and are abundantly grown in northeast Mexico.

Table 1: List of plants studied to determine the leaf nutrient content

Plant species	Family	Growth form	Leaf type
Cordia boissieri A. DC.	Boraginaceae	Tree	Simple
Ehretia anacua (Teran & Berland.) I.M. Johnst	Boraginaceae	Tree	Simple
Helietta parvifolia (A. Gray) Benth	Rutaceae	Shrub	Composite
Fraxinus greggii A. Gray	Oleaceae	Tree	Composite
Amyris texana (Buckley) P. Wilson	Rutaceae	Shrub	Composite
Condalia hookeri M. C. Johnst	Rhamnaceae	Tree	Simple
Leucophyllum frutescens (Berland) I.M. Johnst	Scrophulariaceae	Shrub	Simple
Acacia rigidula Benth.	Fabaceae	Shrub	Composite
Sargentia greggii S. Wats	Rutaceae	Tree	Composite
Diospyros palmeri Eastw	Ebenaceae	Tree	Simple
Diospyros texana Scheele	Ebenaceae	Tree	Simple
Zanthoxylum fagara (L.) Sarg.	Rutaceae	Shrub	Composite
Sideroxylon celastrinum (Kunth) T.D.Penn	Sapotacee	Tree	Simple
Karwinskia humboldtiana (Schult.) Zucc.	Rhamnaceae	Shrub	Simple
Ebenopsis ebano (Berland.) Barneby & J.W. Grimes	Fabaceae	Tree	Composite
Quercus virginiana Mitl.	Fabaceae	Tree	Simple
Celtis pallida Torr	Ulmaceae	Shrub	Simple
Guaiacum angustifolium Engelm	Zygophyllaceae	Shrub	Composite

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Plant species	Family	Growth form	Leaf type
Caesalpinia mexicana A. Gray	Fabaceae	Tree	Composite
Acacia berlandieri Benth.	Fabaceae	Tree	Composite
Acacia farnesiana (L) Willd	Fabaceae	Shrub	Composite
Acacia schaffneri (S. Wat¬son) F.J. Herm	Fabaceae	Tree	Composite
Lantana macropoda Torr.	Verbena-ceae	Shrub	Simple
Leucaena leucocephala (J. de Lamarck) H. C. de Wit	Fabaceae	Tree	Composite
Prosopis laevigata (H. & B.) Jonhst	Fabaceae	Tree	Composite
Bernardia myricifolia (Scheele) Benth. & Hook. F.	Euphro-biaceae	Shrub	Simple
Berberis chococo Schlecht	Berberi-daceae	Shrub	Composite
Celtis laevigata Willd	Ulma-ceae	Tree	Simple
Cercidium macrum I.M. Johnst	Fabaceae	Tree	Composite
Forestiera angustifolia Torr.	Oleaceae	Shrub	Simple
Parkinsonia aculeata L.	Fabaceae	Tree	Composite
Croton suaveolens Presl.	Euphro-biaceae	Shrub	Simple
Salix lasiolepis Benth.	Salica-ceae	Tree	Simple
Gymnosperma glutino-sum (Spreng.) Less	Astera-ceae	Shrub	Simple
Havardia pallens (Benth.) Britton & Rose	Fabaceae	Tree	Composite
Acacia wrightii Benth.	Mimosa-ceae	Tree	Composite
Eysenhardtia polys-tachya Ortega, Sarg.	Fabaceae	Shrub	Composite

2.3. Chemical analysis

By quintuplicate, mature leaf sample tissues were collected from each plant species and placed to dry on newspaper for a week. Leaves were removed from twigs and were passed through a mesh of 1.0×1.0 mm^2 using a mill Thomas Wiley (Thomas Scientific Apparatus, Model 3383®). Subsequently, they were dried for three days at 65 °C in an oven (Lab-Line, Instruments, Inc., model 3476®) to remove moisture from the sample and later these were placed in desiccators. A 2.0 mg of milled dried leaf tissue was weighed using a Perkin-Elmerbalance (modelAD6000®) in a vial of tin and bent perfectly. This was placed in a CHN analyzer Perkin Elmer (Model 2400®) for determining carbon and nitrogen content (%).

Leaf samples (1.0 g dry weight) obtained from each species was used for determining the contents of minerals (Mg, K, P, Cu, Fe, and Zn). Mineral content was estimated by incinerating leaf samples in a muffle at 550 °C for 5 h. Ashed samples were digested in a solution containing HCl and HNO_3 (proportion 10:1, v/v), using the wet digestion technique (Cherney, 2000). Contents of macro- (Mg and K; mg g^{-1} dry weight) and micro-nutrients (Cu, Fe and Zn (mg g^{-1} dry weight) were measured through atomic absorption spectrophotometry (Perkin-Elmer, model Pinnacle 900F®). Phosphorous (P) content was determined spectrophotometrically using a spectrophotometer (Perkin-Elmer, model Lambda 25®) at 880 nm (AOAC, 1997). Nutrient content are reported as means and standard deviation (n=5).

3. Results and Discussion

Table 2 illustrates the data regarding the macro- (Mg, K, P, C and N) and micro-nutrient(Cu, Fe and Zn) contents of studied native shrubs and trees species.

3.1. Macronutrients

The study revealed that phosphorous (P) contentranges from 0.78 to 2.43 mg g^{-1} dry weight. The species containing high P are *C. suaveolens* 2.43, *E. polystachya* 1.84, *P. laevigata* 1.65, *P. aculeata* 1.56, *A. farnesiana* 1.54 and *S. lasiolepis* 1.51 mg g^{-1} dry weight. On the other hand, Mg ranged from 0.22 to 9.45 mg g^{-1} dw. The species containing high Mg are *E. anacua* 9.45, *C. hookeri* 6.50, *P. aculeate* 5.29, *H. parvifolia* 5.17, and *G. angustifolium* 4.1 mg g^{-1} dry weight. With respect to K, it varied from 11.54 to 75.62 mg g^{-1} dry weight where highest K content was recorded by *C. suaveolens* 75.62 followed by *C. boissieri* 45.58, *C. pallida* 42.6, *A. rigidula* 38.75, *D. texana* 36.55, *A. farnesiana* 34.72, *P. laevigata* 34.04, and *S. celastrinum* 33.02 mg g^{-1} dry weight.

Carbon (C) contentin leaves ranged from 30.07 to 49.97%. The species containing high C are *L. frutescens* 49.97, *F. angustifolia* 49.47, *S. celastrinum* 49.25, *A. berlandieri* 49.18, *A. rigidula* 48.23, *G. glutinosum* 46.19, *A. farnesiana* 46.17, C. *suaveolens* 45.17, and *S. greggii* 44.07%.

Nitrogen (N) content in leaf tissue varied from 1.89 to 5.89%. The species containing high N content are *G. glutinosum* 5.89, *L. macropoda* 4.43, *A. schaffneri* 4.32, *B. myricifolia* 4.21, *C. pallida* 4.12, *E. polystachya*4.06, and *C. macrum* 4.01%.

The C/N ratio ranged from 7.85 to 23.13%. The species containing high C/N are *S. greggii* 23.13, *L. frutescens* 22.17, *Q. virginiana* 21.95, *D. texana* 21.58, *S. celastrinum* 20.35, and *C. suaveolens* 20.16%.

Table 2: Leaf nutrient content in different plant species values are means and standard deviation (n=5)

Species	Leaf nutrient content								
	(mg g^{-1} dry weight)			C (%)	N (%)	C/N ratio	(µg g^{-1} dry weight)		
	P	Mg	K				Cu	Fe	Zn
C. boissieri	1.42±0.12	2.72±0.31	45.58±1.65	43.43±1.20	3.28±0.09	13.23±13.38	30.71±0.55	280.55±8.46	51.87±1.80
E. anacua	1.12±0.06	9.45±0.37	16.72±1.18	34.09±2.51	2.44±0.10	13.97±25.10	12.62±0.79	68.90±5.82	40.07±5.31
H. parvifolia	1.01±0.12	5.17±0.45	21.48±1.83	31.13±1.03	2.43±0.25	12.84±4.16	9.11±2.21	72.94±4.97	37.55±9.07
F. greggii	0.88±0.05	1.55±0.54	23.07±1.63	38.06±1.89	2.15±0.14	17.69±13.85	8.16±1.21	125.13±43.75	30.94±3.97
A. texana	1.09±0.08	2.67±0.36	19.56±4.79	38.06±1.89	3.72±0.33	12.79±5.65	9.18±1.17	99.88±31.75	17.40±1.24
C. hookeri	0.89±0.06	6.50±0.84	25.76±3.33	30.07±2.81	3.06±0.41	9.83±6.85	5.02±0.39	73.79±18.44	11.54±3.41
L. frutescens	0.80±0.10	2.69±0.28	13.69±3.10	49.97±0.94	2.25±0.27	22.17±3.51	6.45±0.79	118.12±15.44	27.23±3.79
A. rigidula	1.25±0.14	0.43±0.09	38.75±0.55	48.23±1.56	2.60±0.22	18.58±6.96	7.09±0.36	252.33±3.04	10.23±1.16
S. greggii	0.78±0.04	2.45±0.19	13.19±3.84	44.07±1.22	1.91±0.45	23.13±2.71	4.79±0.47	87.80±18.23	14.48±0.94
D. palmeri	0.96±0.06	2.84±0.92	18.13±1.60	37.59±1.72	2.17±0.12	17.36±14.33	5.36±1.13	92.96±14.59	18.58±5.90
D. texana	0.98±0.08	2.59±0.55	36.55±2.26	40.79±1.46	1.89±0.06	21.58±24.33	2.80±0.16	72.47±22.66	41.45±4.03
Z. fagara	0.99±0.13	2.80±0.46	14.77±2.51	40.35±3.15	2.98±0.90	13.56±3.50	15.66±3.17	112.80±22.32	18.92±2.80
S. celastrinum	0.09±0.78	0.68±0.13	33.02±1.30	49.25±1.56	2.42±0.36	20.35±4.38	25.24±1.50	249.00±15.03	14.10±7.38
K. humboldtiana	1.05±0.12	1.31±0.37	16.41±2.28	31.35±0.70	2.84±0.10	11.03±6.91	5.86±0.75	70.41±12.17	13.19±1.61
E. ebano	0.90±0.03	2.88±0.25	14.06±1.27	37.57±1.21	3.86±0.20	9.73±6.05	8.85±2.14	130.60±94.49	17.21±3.81
Q. virginiana	0.91±0.07	2.60±1.34	15.04±1.37	43.02±2.38	1.96±0.18	21.95±13.22	3.63±0.50	66.32±13.19	39.25±3.88
C. pallida	1.24±0.18	3.20±0.25	42.60±0.90	38.66±0.88	4.12±0.67	9.38±1.32	25.98±1.04	276.89±5.70	12.42±0.29
G. angustifolium	0.80±0.18	4.10±0.87	12.69±1.32	41.89±3.56	2.90±0.42	14.44±8.48	3.99±2.07	83.30±6.70	20.59±4.08
C. mexicana	1.29±0.23	1.20±0.12	13.32±1.88	41.12±1.96	2.91±0.38	14.13±5.16	4.55±0.96	48.47±19.26	17.36±5.74
A. berlandieri	0.78±0.08	2.69±0.41	6.80±2.10	49.18±1.25	3.82±0.14	12.88±8.89	3.52±0.62	73.46±8.01	15.08±3.61
A. farnesiana	1.54±0.11	0.22±0.17	34.72±2.20	46.17±2.63	3.41±0.18	13.54±14.61	24.62±1.11	259.76±2.66	15.47±0.83
A. schaffneri	1.44±0.22	1.72±1.17	19.86±1.77	39.52±0.99	4.32±0.16	9.15±6.19	3.18±0.94	138.93±32.25	44.6±5.71

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Species	Leaf nutrient content								
	(mg g-1 dry weight)			C (%)	N (%)	C/N ratio	(µg g-1 dry weight)		
	P	Mg	K				Cu	Fe	Zn
L. macropoda	1.37±0.06	3.71±0.31	26.04±2.04	42.91±3.74	4.43±0.39	9.68±9.53	13.00± 0.22	145.81± 48.14	28.29± 4.72
L. leucocephala	0.98±0.05	2.60±0.38	14.21±2.03	43.16±1.98	3.78±0.50	11.42±3.96	6.03± 0.41	77.59± 2.20	11.06± 1.12
P. laevigata	1.65±0.29	2.88±1.12	34.04±2.03	41.64±0.71	3.85±0.21	10.83±3.38	5.17± 1.53	128.92± 41.18	48.47± 11.71
B. myricifolia	1.09±0.10	3.61±0.38	11.54±1.18	42.69±1.13	4.21±0.49	10.13±2.30	8.03± 0.85	139.73± 24.69	16.17± 0.93
B. chococo	0.90±0.05	2.35±0.86	12.42±2.06	36.91±1.25	2.43±0.19	15.17±6.71	5.12± 0.38	58.79± 13.95	50.68± 9.41
C. laevigata	1.57±0.23	2.19±0.27	20.67±3.28	39.45±0.51	3.01±0.18	13.13±2.78	8.88± 2.09	254.09± 40.44	42.28± 5.49
C. macrum	1.10±0.11	2.95±0.87	14.5±6.07	43.41±3.44	4.01±0.30	10.83±11.47	5.97± 1.50	96.08± 24.65	25.29± 5.86
F. angustifolia	0.89±0.06	1.27±0.35	28.32±3.61	49.47±0.43	3.00±0.41	16.47±1.04	4.03± 0.39	70.10± 11.86	48.56± 6.13
P. aculeata	1.56±0.35	5.29±1.82	24.93±2.81	36.63±3.25	3.04±0.41	12.05±7.93	7.44± 2.20	165.63± 69.17	51.66± 8.09
C. suaveolens	2.43±0.14	0.22±0.09	75.62±3.67	45.17±0.35	2.33±0.53	20.16±0.67	26.87± 1.66	229.13± 24.25	34.55± 4.11
S. lasiolepis	1.51±0.09	2.34±1.18	23.57±1.54	33.37±4.58	2.06±0.50	16.24±9.16	8.49± 0.52	95.49± 13.15	144.86± 12.77
G. glutinosum	1.40±0.04	1.90±0.13	21.49±3.31	46.19±1.04	5.89±0.29	7.85±3.54	8.93± 2.40	167.40± 13.81	12.16± 1.64
H. pallens	1.11±0.11	3.15±0.68	22.86±2.52	43.49±1.24	2.97±0.15	14.64±8.27	3.51± 0.46	109.87± 10.53	29.57± 6.38
A. wrightii	1.22±0.19	3.03±1.23	20.5±3.41	36.59±1.11	3.96±0.18	9.25±6.22	8.11± 2.97	99.04± 23.21	28.14± 2.29
E. polystachya	1.84±0.22	2.22±0.24	16.43±2.54	36.26±0.58	4.06±0.27	8.94±2.15	16.16± 2.92	82.86± 10.47	51.39± 10.66

3.2. Micronutrients

Cu content (µg g^{-1} dry weight) ranged from 2.8 to 30.71. The species containing high Cu were *C. boissieri* 30.71, *C. suaveolens* 26.87, *C. pallida* 25.98, *S. celastrinum* 25.24, *A. farnesiana* 24.62, *E. polystachya* 16.16, *Z. fagara* 15.66, *L. macropoda* 13, and *E. anacua* 12.62 µg g^{-1} dry weight.

Fe content (µg g^{-1} dry weight) in leaf tissue ranged from 48.47 to 280.55. The species containg high Fe are *C. boissieri* 280.55, *C. pallida* 276.89, *A. farnesiana* 259.76, *C. laevigata* 254.09, *A. rigidula* 252.33, *S. celastrinum* 249, *C. suaveolens* 229.13, *G. glutinosum* 167.4, *P. aculeata 165.63*, *L. macropoda* 145.81, *B. myricifolia* 139.73, and *A. schaffneri* 138.93 µg g^{-1} dry weight.

Zn content (µg g^{-1} dw) varied from 10.23 to 144.86. The species containing high Zn are *S. lasiolepis* 144.86, *C. boissieri* 51.87, *P. aculeata* 51.66, *E. polystachya* 51.39, *F. angustifolia* 48.56, *P. laevigata* 48.47, *A. schaffneri* 44.60, *C. laevigata* 42.28, *D. texana* 41.45, and *E. anacua* 40.07 µg g^{-1} dry weights.

In the context of the above results it may be stated that the species show a large variation in the contents of five macro (P, Mg, K, C and N) and three micro-nutrients Cu, Fe and Zn), thereby offering opportunity to select species for high macro and micronutrients.

In the context of the present results and literatures it is stated that leaves contribute greatly for plant growth and development (Wright et al., 2001), function as sources of nutrients for grazing animals (Reid et al., 1990). The importance of plant nutrients as sources of forage for ruminants and for the growth and development was emphasized by various authors. Plants with nutrient conservation have long life and high leaf mass per area, low nutrient concentrations and low photosynthetic capacity (Reich et al., 1997). The availability of nutrients in leaves is essential for efficient plant function. Chapin (1980) mentioned the importance the nutritional studies of nitrogen and phosphorus for plant growth. Leaf nutrient contents depends on the availability of nutrients present in the soil habitat Nutrient-poor habitats tend to be dominated by species by nutrient-conserving species, while fertile habitats tend to be dominated by species with higher short-term productivity per leaf mass (Chapin et al., 1990). Within a given habitat, species with a range of leaf traits can coexist (Reich et al., 1999). The nutrient contents of leaves vary with the age of leaves. With the age of leaves, nutrient resorption occurs when nutrients are withdrawn from leaves prior to abscission and reemployed in the developing tissues (leaves, fruits, seeds). Resorption occur throughout a leaf s life particularly when the leaves are shaded (Ackerly and Bazzaz, 1995; Hikosaka et al., 1996). After leaf senescence, reabsorption of nutrients occur in most of the species (Nooden, 1998). The all the species having the presence of active nutrient have control over reabsorption (Negi and Singh, 1993).

4. Conclusion

The species selected for the highest macro- and micro-nutrients may be utilized for confirming their physiological efficiency and probable better growth and productivity. The species having high nutrients could serve as good source for the plants during nutrient deficiency to sustain growth and good sources of nutrients for grazing wild animals.

5. Acknowledgement

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6. References

Ackerly, D.D., Bazzaz, F.A., 1995. Leaf dynamics, self-shading and carbon gain in seedlings of a tropical pioneer tree. Oecologia 101(3), 289–298.

Aerts, R., 1996. Nutrient resorption from senescing leaves of perennials: are their general principles? Journal of Ecology 84(4), 597–608.

AOAC, 1997. Official methods of analysis (16th Edn.), Association of Official Analytical Chemists, Washington, DC.

Chapin, F.S., 1980. The mineral nutrition of wild plants. Annual Review of Ecology, Evolution and Systematics 11(2), 233–260.

Chapin, F.S., Schulze, E.D., Mooney, H.A., 1990. The ecology and economics of storage in plants. Annual Review of Ecology and Systematics 21, 423–447.

Cherney, D.J.R., 2000. Characterization of forages by chemical analysis. In: Givens, D.I., Owen, E., Axford, R.F.E., Omed, H.M. (Eds). Forage Evaluation in Ruminant Nutrition. CAB International, Wallingford, UK, 281–300.

Gomez, T.G.D., Ramirez Lozano, R.G., Estrada Castillon, A.E., Scott Morales, L.M., Rodriguez, H.G., Alvarado, M.S., 2012. Importancia nutrimental en plantas forrajeras del matorral espinoso tamaulipeco. Ciencia UANL 15(59), 77–93.

Hikosaka, K., Terashima, I., Katoh, S., 1996. Effects of leaf age, nitrogen nutrition and photon flux density on the organization of photo-synthetic apparatus in the leaves of a vine (*Ipomoea tricolor* Cav,) grown horizontally to avoid natural shading of leaves. Planta 194(4), 451–457.

Lukhele, M.S., Van Ryssen, J.B.J., 2003. Chemical composition and potential nutritive value of subtropical tree species in southern Africa for ruminants. African Journal of Animal Science 33(2), 132–141.

McMurtry, C.R., Barnes, P.W., Nelson, J.A., Archer, S.R., 1996. Physiological responses of woody vegetation to irrigation in a Texas subtropical savanna, 33–37, in La Copita Research Area: 1996 Consolidated Progress Report. Texas Agricultural Experiment Station-Corpus Christi, Texas A&M University System, College Station, TX.

Negi, G.C.S., Singh, S.P., 1993. Leaf nitrogen dynamics with particular reference to retranslocation in evergreen and deciduous tree species in Kumaun Himalaya. Canadian Journal of Forest Research 23(3), 349–357.

Nooden, L.D., 1988. The phenomena of senescence and ageing. In: Nooden, L.D., Leopold, A.C. (Eds.). Senescence and Aging in Plants. Academic Press, The University of Michigan. Michigan, USA, 526.

Northup, B.K., Zitzer, S.F., Archer, S.R., Boutton, T.W., 1996. A technique to allocate biomass of woody plants, 47–50, in La Copita Research Area: 1996 Consolidated Progress Report. Texas Agricultural Experiment Station-Corpus Christi, Texas A&M University System, College Station, TX.

Ramirez Lozano, R.G., 2014. Native shrubs: edible foliage for small ruminants. In: Mait, R., Rodriguez, H.G., Thakur, A.K., Sarkar, N.C., (Eds.), Applied Botany Puspa Publishing House, Kolkata, India, 165–180.

Reich, P.B., Ellsworth, D.S., Walters, M.B., Vose, J.M., Gresham, C., Volin, J.C., Bowman, W.D., 1999. Generality of leaf trait relationships: a test across six biomes.

Ecology 80, 1955–1969.
Reich, P.B., Walters, M.B., Ellsworth, D.S., 1997. From tropics to tundra: global convergence in plant functioning. Proceedings of the National Academy of Sciences, USA, 94, 13730–13734.
Reid, N., Marroquin, J., Beyer-Münzel, P., 1990. Utilization of shrubs and trees for browse, fuel wood and timber in the Tamaulipan thornscrub, north-eastern Mexico. Forest Ecology and Management 36, 61–79.
Rengel, Z., Marschner, P., 2005. Nutrient availability and management in the rhizophere: exploting genotypic differences. New Phytologist 168(2), 305–312.
Rodriguez, H.G., Cantu Silva, I., Gomez Meza, M.V., Ramirez Lozano, R.G., 2004. Plant water relations of thornscrub shrub species, northeastern Mexico. Journal of Arid Environments 58(4), 483–503.
Rodriguez, H.G., Cantu-Silva, I., Ramirez-Lozano, R.G., Gomez-Meza, M.V., Uvalle-Sauceda, J.I., Maiti, R.K., 2010. Characterization of xylem water potential in ten native plants of north-eastern Mexico. International Journal of Bio-resource and Stress Management 1(3), 219–224.
Wright I.J., Reich P.B., Westoby, M., 2001. Strategy shifts in leaf physiology, structure and nutrient content between species of high-and low-rainfall and high- and low-nutrient habitats. Functional Ecology 15(4), 423–434.