

Altitudinal distribution of leguminous nitrogen fixing trees in east Nepal

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There is a gap of knowledge about the nitrogen fixing leguminous trees in Nepal. Present paper is the first attempt of research on the distribution of such trees at the different physiographic regions of the country's eastern region. Of the forty five leguminous trees observed growing from the Terai to the high himal, thirty five have nodules. The Mimosoidea has the highest members of nodulating trees and the Caesalpinioideae has the lowest. Increase in altitude negatively effects the occurrence of nodulating trees. Seventy to six hundred metres is the altitude range most suitable for the occurrence of the nodulating trees.

Keywords : Nodulation, Leguminous nitrogen fixing trees. Nepal.

Leguminosae is one of the largest and economically important families widely distributed in the tropics of the world (Polhil and Raven 1981). A large number of leguminous species have been extensively studied and reported to be nitrogen fixing (Allen and Allen 1981). Nitrogen-fixing plants (NFPs) are significantly important as they are able to grow in wide and adverse climatic conditions (Davey and Wollum 1984; Pokhriyal, *et al.* 1992) and improve soil fertility.

Most of the tree legumes are fast growing which coppice well and are of multipurpose use. For their soil-enrichment properties, the potential of these trees are being explored worldwide (Giller and Wilson 1991; Kadiata and Mulogony 1992). Their role is being increasingly recognised for both intensive and extensive agroforestry systems (Gutteridge and Shelton 1994).

Following the classic work of Allen and Allen (1981), the screening of N-fixing leguminous species has been progressively going on. Nonetheless, only 16% legume species have been investigated so far. And it is accepted that of the three sub-families, highest root nodulating plants are distributed in Papilionoideae and lowest in Caesalpinioideae (Allen and Allen 1981; Faria *et al.* 1984, 1987; Pokhriyal *et al.* 1993).

In the east Nepal, the leguminous plants constitute a sizable portion of the flora. They exhibit a wide range of habit such as small annual weed, woody climbers and big trees. The systematic studies on the identification and distribution of N-fixing leguminous trees have not yet been carried out properly in Nepal. This study is therefore, conducted to know the altitudinal distribution of the nodulated tree legumes from the Terai plains (alt. 70 m) to the tree-line (above 3800 m) in the east Nepal.

Materials and methods

The study area falls under Koshi watershed. It lies between the longitude 86° 09' and 88° 12' E and the latitude 26° 22' and 28° 07' N and covers about 28540 km² land area (MPFS, 1988). All the five physiographic regions of Nepal such as Terai, Siwaliks, Middle Mountains, High Mountains and High Himalaya are also represented.

Excepting the High Himalaya which lies beyond the tree-line, two-hundred and forty seven rectangular sample plots (50 m x 100 m) were laid along a certain transect in the four ago-climatic zones. The criteria determined for layout of the sample plots were, (i) distance in the plains and (ii) altitudinal rise in the hills. The nodulation ability of both the exotic and indigenous legume trees were examined randomly within a maximum distance of 250 m on

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either sides of the sample points. Presence of nodules in the roots was taken as the main characteristic for identification of legume NFPs.

Results

Of the forty five leguminous NFT species (of three sub-families) found distributed from the Terai to timber-line, only thirty five had nodules (Table 1).

Table 1: Distribution of nodulating and non-nodulating leguminous trees

S. No.	Species	Vernacular/ Local name	Nodulation Behavior	Distribution
1	<i>Acacia auriculiformis</i> A.Cunn. & Benth.	Watal	Positive	60-550 m, Biratnagar, Chandragadhi, Jhumka, Letang, Tarhara, Hattisar and Ghorlikharaka.
2	<i>A. catechu</i> (Linn.f.) Willd.	Khair	"	60-1000 m, Biratnagar, Suraga, Phidim, Himakhola, Chattra- Barahachhetra, Chanuwa -Diyale,
3	<i>A. holosericea</i> A.Cunn. ex G.Don	-	"	350-550 m, introduced in Manmaya and Ghorlikharka
4	<i>A. nilotica</i> (Linn.) Del. ssp. <i>indica</i> (Benth.) Brenan	Babul	"	60-250 m, Biratnagar, Birtamod, Letang.
5	<i>Acrocarpus fraxinifolius</i> Wight & Arn.		Negative	60-160 m, Tarhara, Kanepokhari, Jalthal,
6	<i>Albizia armra</i> (Roxb.) Boiv.	Lahare siris	"	200-750 m, Ampgachi, Churia Danda, Dovan.
7	<i>A. chinensis</i> (Obs.) Merr.	Rato siris	Positive	60-2000 m, Biratnagar, Ilam, Phidim, Taplejung, Chainpur, Khandbari, Suketar.
8	<i>A. falcataria</i> (Linn.) Fosberg		"	60-600 m, introduced in Amaduwa, Biratnagar, Dharan.
9	<i>A. julibrissin</i> Duraz.	Siris	"	1400-2150 m, Himakhola, Nagigaon, Dutiya village.
10	<i>A. lebbeck</i> (Linn.) Benth.	Kalo siris	"	60-1500 m, Biratnagar, Piteni, Himakhola, Phidim, Hangdewa, Dovan-Sisne, Malbase, Leguwa, Balute.
11	<i>A. lucidior</i> (Steud.) Nielsen	Patke siris	"	60-1500 m, Jalthal, Santinagar, Phidim, Biratnagar, Pnmara-Hattisar, Phattepur, Ballet, Chanting, Gandhi, Mithlung, Hangdewa, Hellok, Pakhribas.
12	<i>A. odoratissima</i> (Linn. f.) Benth.	Khankar	"	60-1100 m, Jalthal, Santinagar, Nakedanda, Sesambu, Diyale, Leguwa, Rajarani, Himakhola.
13	<i>A. procera</i> (Roxb.) Benth.	Seto siris	"	60-800 m, Biratnagar, Hangdewa, Kane-pokhari, Chattra, Panmara, Jalthal, Mulghat, Tumlingtar, Katari, Dharan-Dhankuta road.
14	<i>Bauhinia purpurea</i> Linn.	Tanki	Negative	60-1200 m, Biratnagar, Jalthal, Kanepokhari, Khandabari, Chainpur
15	<i>B. Variegata</i> Linn.	Koiralo	"	800-1200 m, Aampgachi, Dhankuta, Karkichhap, Ghadi
16	<i>Butea monosperma</i> (Lam.) Taub.	Palash	Positive	100-350 m, Itahari, Phattepur, Chriadanda, Letang, Goathgaon.
17	<i>Calliandra calothyrsus</i> Meissn.	-	"	60-300 m, introduced, Amaduwa, Biratnagar, Dharan.
18	<i>Cassia fistula</i> Linn.	Rajbriksh	Negative	60-200 m, Biratnagar, Kanepokhari, Tarahara, Churiadanda.
19	<i>C. siamea</i> Lam.	-	"	60-300 m, Biratnagar, Letang, Tarhara, Jalthal.

20	<i>C. surattensis</i> Burm. f. ssp. <i>glauca</i> (Lam.) K. & S.	-	"	60-100 m, Biratnagar, Jalthal.
21	<i>Dalbergia latifolia</i> Roxb.	Satisal	Positive	90-900 m, Phattepur, Jahada, Kanepokhari, Chattra, Tarahara, Panchkanya, Arun River, Katari, Mulghat, Karkichhap.
22	<i>D. sericea</i> G. Don		"	800-1800 m, Ampgachhi-Bhedetar, Dharapani, Mithlung, Tamor Dovan, Phidim, Khatekhola, Banjogara, Dhojedanda, Sekathum, Simsuwa, Karkichap, Chisapani.
23	<i>D. sissoo</i> Roxb.	Sissoo	"	60-1000 m, Terai to 1000 m, widely cultivated.
24	<i>Delonix regia</i> (Bojer ex Hook.) Rafin.	Goldmour	Negative	60-550 m, Biratnagar, Letang, Ghorlikharka, Phattepur.
25	<i>Derris robusta</i> (Roxb. ex DC.) Benth.	-	Positive	300 m, Santinagar.
26	<i>Erythrina arborescens</i> Roxb.	Roringo	"	1000-2200 m, Change, Tawa, Takma, Tamor Dovan- Taplejung, Phikal, Hellok, Iladanda, Karkichhap, Pakhribas, Kagate, Chhintang, Hile, Dandabazar, Mamling, Gadhi, Pathibhara, Nangiganoo, Suketar.
27	<i>E. stricta</i> Roxb.	Phaledo	"	60-1400 m, Biratnagar, Amaduwa, Dharan basecamp, Katari, Barne, Dhancuta, Bajhogara.
28	<i>E. suberosa</i> Roxb.	Phaledo	"	750-2000 m, Ampgachhi, Dhankuta, Kagate, Pathibhara, Chattra.
29	<i>Faidherbia albida</i> (Delile.) Chiov.	-	"	350 m, introduced in Manmaya.
30	<i>Glericidia sepium</i> (Jacq.) Kunth ex Walp.	-	"	60-350 m, introduced in Biratnagar to Dharan.
31	<i>Indoptadenia oudhensis</i> (Brandis) Brenen	Mauli	"	200-350 m, Churiadanda.
32	<i>Leucaena diversifolia</i> (Schlecht.) Benth.	Epil	"	60-300 m, introduced in Amaduwa, Biratnagar, Dharan.
33	<i>L. esculenta</i> (Moc.& Sesse) Benth.	-	"	350-550 m, introduced in Manmaya and Ghorlikharka.
34	<i>L. leucocephala</i> (Lam.) de Wit	Epil Epil	"	60-1550 m, Biratnagar, Tarahara, Shantinagar, Dhankuta, Taplejung.
35	<i>L. salvadorensis</i> Standley, Britton & Rose.	-	"	550 m, introduced in Ghorlikharka.
36	<i>L. shannoni</i> Donn. & Smith.	-	"	550 m, introduced in Ghorlikharka.
37	<i>Ormosia glauca</i> Wall.	Chamre	"	150-700 m, Chattra, Seutikhola, Phattepur, Phedibazar, Balaute.
38	<i>Ougeinia oojinensis</i> (Roxb.) Hochr.	Sandan	"	100-850 m, Phattepur, Tribeni, Katari, Chattra, Kanepokhari, Bahune, Sesambu, Himakhola, Manebhanjyang.
39	<i>Peltophorum pterocarpum</i> (DC.) Baker ex Heyne	-	"	60-300 m, Biratnagar, Tinkune.
40	<i>Pithecellobium dulce</i> (Roxb.) Benth.	Jungle julebi	"	60-100 m, Biratnagar, Inaruwa.

41	<i>Pterocarpus marsupium</i> (Roxb.)	Vijay sal	"	100-150 m, Bayarban, Letang.
42	<i>Samanea saman</i> (Jacq.) Merr.	-	"	75m, introduced in Amaduwa.
43	<i>Saraca asoca</i> (Roxb.) de Wilde	Ashok	Negative	70-450 m, Katahari, Biratnagar, Pindeswori.
44	<i>Sesbania grandiflora</i> (Linn.) Poir.	Agasti	Positive	60-100 m, Biratnagar, Inaruwa.
45	<i>Tamarindus indica</i> Linn.	Imli	Negative	60-700 m, Biratnagar, Himakhola, Sesambu, Dokhu, Dovan, Inarwa, Chatara, Tamor-Tribeni, Lamibazar, Kholakhark, Basera.

Mimosoideae had maximum (21) nodulating tree species, followed by 13 in Papilionoideae and minimum (1) in Caesalpinioideae (Fig 1).

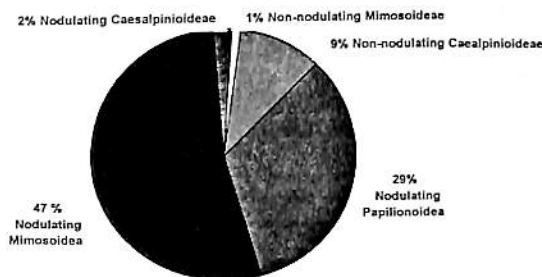


Figure 1 : Percent of nodulating and non-nodulating tree species.

Of the six altitudinal ranges (0-600 m, 600-1200 m, 1200-1800 m, 1800-2400 m, 2400-3000 m and above 3000 m) designated for the present study, maximum 31 (19 restricted between 0-600 m, 7 between 0-1200 m, 4 between 0-1800 m and 1 between 0-2400 m) tree species were found to be originated in 0-600 m (Table 2).

Albizia was found to be the most frequently distributed genus which has seven nodulating tree species. This was followed by *Leucanea* with 5, *Acacia* with 4; three each for *Dalbergia* and *Erythrina* and the rest 13 genera each with 1 species. Of the thirty five nodulated tree species, *Albizia chinensis* distributed from 0 to 2400 m range. Majority of the nodulating leguminous trees were observed to be distributed up to 1000 m, beyond this altitude there was a gradual decrease to about 1800 m, above 1800 m there was a marked reduction in their occurrence and almost absent from 2400 m onwards (Table 2).

Discussion

The nodulation of individual plant of different leguminous sub-families, as observed in the present

study is in conformity with the earlier reports (Allen and Allen 1981; Faria *et al.* 1984, 1987; Pokhriyal *et al.* 1993). The reasons for their presence or absence in different altitudinal ranges may be due to the variations in individual's adaptability towards different agro-climatic zones (K.C. 1997). Occurrence or non-occurrence of the leguminous NFTs in respect to the altitudinal ranges have indicated that the species either follow a systematic repetition in a continuous manner from one range to the others or confined to a range or ranges. It may be stipulated that the distribution frequency of different nodulating tree legumes have followed almost an altitudinal sequential trend in east Nepal.

Albizia armara which is the lone species that lacked nodulation supports to the earlier findings of Allen and Allen (1981) that some species may be negative to nodulating behaviour even of the same genus. Factors such as environmental, physiological and biochemical conditions, soil pH value, N level and plant nutrients have shown to influence the nodulating process (Gibson 1980), non-nodulation of *Albizia armara* could be one of them which needs confirmation.

Conclusion

Our knowledge of biological nitrogen fixation in the forest ecosystem is meager. The main attention should, therefore, be paid to screen the promising native, domesticated and naturalized species with suitable propagation as well as site improvement techniques. The present communication on the leguminous NFTs growing at different altitudes and at various agro-climatic zones of the eastern Nepal, might fill such gaps. And it could be utilised in forestry as well as agro-forestry plantations, so that the degraded forest and watershed areas could be reclaimed for fulfilling the local peoples' need of fodder, fuelwood, and timber.

Table 2: Altitudinal distribution of nitrogen fixing tree species in the east Nepal

S. No.	Species	Altitudinal Range (m)			
		0-600	600-1200	1200-1800	1800-2400
1	<i>Acacia auriculiformis</i>	I-----I			
2	<i>A. catechu</i>	I-----I			
3	<i>A. holosericea</i>	I-----I			
4	<i>A. nilotica</i> ssp. <i>indica</i>	I-----I			
5	<i>Albizia chinensis</i>	I-----I			
6	<i>A. falcataria</i>	I-----I			
7	<i>A. julibrissin</i>			I-----I	
8	<i>A. lebbek</i>	I-----I			
9	<i>A. lucidior</i>	I-----I			
10	<i>A. odoratissima</i>	I-----I			
11	<i>A. procera</i>	I-----I			
12	<i>Butea monosperma</i>	I-----I			
13	<i>Calliandra calothyrsus</i>	I-----I			
14	<i>Dalbergia latifolia</i>	I-----I			
15	<i>D. sericea</i>		I-----I		
16	<i>D. sissoo</i>	I-----I			
17	<i>Derris robusta</i>	I-----I			
18	<i>Erythrina arborescens</i>		I-----I		
19	<i>E. stricta</i>	I-----I			
20	<i>E. suberosa</i>		I-----I		
21	<i>Faidherbia albida</i>	I-----I			
22	<i>Glericidia sepium</i>	I-----I			
23	<i>Indopiptadenia oudhensis</i>	I-----I			
24	<i>Leucaena diversifolia</i>	I-----I			
25	<i>L. esculenta</i>	I-----I			
26	<i>L. leucocephala</i>	I-----I			
27	<i>L. salvadorensis</i>	I-----I			
28	<i>L. shannoni</i>	I-----I			
29	<i>Ormosia glauca</i>	I-----I			
30	<i>Ougeinia oojeinensis</i>	I-----I			
31	<i>Peltophorum pterocarpum</i>	I-----I			
32	<i>Pithecellobium dulce</i>	I-----I			
33	<i>Pterocarpus marsupium</i>	I-----I			
34	<i>Samanea saman</i>	I-----I			
35	<i>Sesbania grandiflora</i>	I-----I			

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