ISSN 2320-5407 International Journal of Advanced Research (2014), Volume 2, Issue 6, 295-299

ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Facilitative effects of Coriaria nepalensis on tree seedlings at degraded and eroded sites.

Deepti Goel

Department of Botany, D.S.B. Campus, Kumaun University, Naini Tal – 263 002, Uttarakhand, INDIA

Manuscript Info

Manuscript History:

Received: 15 April 2014
Final Accepted: 26 May 2014
Published Online: June 2014

Key words:
Coriaria nepalensis, facilitative, degraded, nurse species.

Corresponding Author

Deepti Goel

Abstract

In this study we examine the facilitative effect of Coriaria nepalensis Wall. verns. on tree seedlings at two contrasting microsites (open and canopy). Present study showed a greater height and diameter growth in under canopy microsites than in open microsites for seedlings because of the nursing effect of Coriaria nepalensis, thus can be used to give a shelter to tree seedlings.

INTRODUCTION

The influence of interactions between species on the structure of plant communities has been elucidated through studies that identify mechanisms such as resource competition and facilitation (Holmgren et al., 1997). Although positive plant interaction were recognized early and assigned a major role as the reaction process in Clements' (1916) theory of plant succession, they were generally ignored in Ecology. Recently, however, there has been renewed appreciation of the role of facilitation systems.

Studies of the nurse plant syndrome have focussed on the interaction among just two or at most three species (Franco and Pizana et al., 1995; Morris and wood, 1989), the relationship between nurse species and understorey productivity (Callaway et al. 1995) or the spatial relations among all woody plants and shrub forming nurse canopies (Franco and Pizana et al., 1995). Microorganisms reside in soil and make the soil rich in nutrients either through decomposition or nitrogen fixation. There are a large number of free- living and symbiotic bacteria and cyanobacteria which fix N_2. In addition a number of actinomycetes (e.g. Frankia) develop root nodules on non-legumes and contribute in nitrogen economy in nutrient poor soil (Goodfellow and Williams, 1993). In Himalaya some of the host plants (i.e. Coriaria nepalensis) are typically colonizer of nutrient-poor soils in habitats such as eroded soils and rocky surfaces. Many of the plants themselves do not yield economic goods, but they can promote the growth of more useful plants (Sylvester, 1983) and have potential for reclamation of nutrient poor soils.

A number of factors affecting the rate of plantation understorey colonization by native (or naturalized) tree and shrub species are suggested by these and other successional studies in plantations, abandoned pastures, mined lands in both tropical and temperate regions. These factors relate to initial site conditioned as well as plantation design and management practices.

Degradation and deforestation, to a considerable extent, have created many adverse effects on the landforms in terms of alterations of topography, interruption of natural drainage pattern, disruption of surface. Soil disturbance is matter of great concern because soil formation and development are very time-taking processes (NRC, 1991).

In Central Himalaya the monsoon rainfall pattern divides the summer into two parts, the early dry summer (April to Mid- June) and the late wet summer, with > 75% of annual rainfall coming during mid- June to Mid-September. The water deficit during early summer and winter seems to pose problems for plant growth (Singh et al. 1990). In most of the elevational range of the forested zone (from foot hills to about 3000m) evergreen trees with a leaf life span of about 1 year predominate in terms of standing crops, though deciduous species occur in similar number (Ralhan et al., 1985 a & b). The evergreens renew approximately, all their leaves annually and put out leaves and shoots with deciduous species during the dry summer. Thus shoot extension and leaf growth of both evergreen and deciduous plants are influenced by similar climatic conditions. However, deciduous species shed their leaves soon after the wet summer, while the evergreens retain them throughout the winter; leaves are shed during the dry summer at the time of new shoot growth (Ralhan et al., 1985 a & b). Restoration of degraded hill slopes is one of the most challenging conservational problems in the Himalaya. The inherent geological fragility is a serious constraint on managing natural resources, The ability of the Coriaria nurse other woody plants can be used to stabilizing hill slopes, to regenerate them and to promote species diversity.

Study Site

The study site, Hanumangarh (200 ha area) was affected by massive landslide in the past, and has not yet stabilized. Such a situation is common in Himalaya. The hill slopes near Hanumangarh are directly connected to the east of Nainital city. Any further mass movement may lead to destabilization of the township, which needs immediate attention. Revegetation may not completely check landslides, but can help binding loose silt mass. Only a sparse vegetal cover, mainly of Coriaria, has developed on hill slopes of Hanumangarh. The pH of the site is high, and that might have prevented other species to expand. Coriaria is known to grow well on limestone near Mussoorie. So far as we know this should be among the most severe conditions for plant growth in the region. We found that Coriaria is most effective colonizer of such nutrient poor sites with high pH (degraded site, eroded slopes).

Notes: The study site lies in a structurally complex zone. Neotectonic activities along the Nainital fault and main boundary thrust (MBT) are the major causes, which have made the site very unstable. These are the factors responsible for landslide and creeps in the area. The rocks exposed around the study area belong to the lower and upper Krol formation of the Krol thrust.

Material and Methods

Two-yr-old seedlings along with polyethylene bags (22 x 13 cm) of P. roxburghii (chir pine) and Q. leucotrichophora (banj oak) were placed under Coriaria crown (canopy) and open habitats in April, 1998. Seedlings of each species in two habitat types were observed at monthly intervals to describe growth characteristics such as height growth, diameter at ground level, leaf number per seedlings and leaf area per leaf. Thus the experiments only revealed the effect of aboveground environment created by Coriaria. Seedling diameter was measured to nearest 0.1 mm in two directions (at right angle to one another side). To determine leaf area 50 leaves were marked immediately after bud break (i.e. April) and their length and width were measured to the nearest o.1 cm at weekly intervals. Correlation between leaf area by planimeter ($n = 50$) and the area by product of length and width of leaves was developed according to the following regression equation: $Y = 4.952+ 0.423X$ ($r = 0.9843$, $P<0.01$)

Where X = length x width of leaf, Y = leaf area

Results

In the beginning of the study, average diameter at ground level (dgl) ranged from 3.45-3.49 mm to 2.61-2.92 mm for oak and pine seedlings, respectively. Diameter increment during April-October was greater in the undercanopy habitat than in open habitat. Subsequently, after the rainy season seedlings showed stem shrinkage. The shrinkage was more in pine seedling than oak and in open habitat than canopy habitat (Table 1.3).

On average initial height of oak and pine seedlings ranged from 7.5-8.5 cm and 12.0-12.4 cm, respectively. A significantly greater height growth occurred in the under canopy habitat than in open for both oak and pine seedlings. The seasonal pattern of growth was characterized by rapid growth immediately after bud break in April and again during rainy season. The rate of height growth was significantly greater in the under canopy (0.044-0.059 cm d^{-1}) than in open habitat (0.024 cm d^{-1}) (Table 1.2).

The seedling mortality started in November, a couple of months after the rains topped and continued till February-March. Of the total seedlings, only 25% pine seedlings survived in the open. In the undercanopy environment seedling mortality was 40% and 35% for oak and pine seedlings, respectively (Table 1.1).

In the beginning, the average leaf number was 9.5 and 8.9 leaves per seedling at open and canopy habitat, respectively. Of the total leaf recruitment 65% occurred in spring and remaining 24% occurred during the rainy season (Table 1.5).

The leaf expansion in oak seedling started just after bud break and took about seven weeks for full expansion. These findings are consistent with the earlier studies on oak trees (Dhaila, 1991) (Table 1.5).

Discussion

Plants may facilitate other plants directly, by ameliorating harsh environmental characteristics, or increasing the availability of a resource (e.g. Miller 1994). Since 1927, when Aikman quantified environmental differences between subcanopy and open microhabitats in deciduous forests of eastern Nebraska, ecologists have measured many changes in microhabitat caused by plants that favour the growth and survival of other plant species.

The open microsites of the present study were exposed to severe desiccating conditions due to high radiation, while the canopy of Coriaria restricted evaporation loss, resulting in a more humid condition. In conformity to previous studies (Chen et al., 1995), under the canopy light intensity was reduced, soil and air temperature were lower than in the open habitat. These changes result in lower transpiration demands and lower evaporation (Joffree & Rambal, 1988; Vetaas, 1992; Barton, 1993). Present study showed a greater height and diameter growth in undercanopy microsites than in open microsites for seedlings because of the nursing effect of Coriaria nepalensis. Coriaria thus can be used to give shelter to seedlings.

Table 1.1: Seedling mortality (oak and pine seedlings) in open and undercanopy microsites at eroded site.

	Oak		**Pine**	
	Open	**Undercanopy**	**Open**	**Undercanopy**
Initial number of seedlings	20	20	20	20
Month when mortality commenced	Nov.	Dec.	Dec.	Dec.
Period of seedling mortality	Nov.-March	Dec.-Feb.	Dec.-March	Dec.-March
% mortality	100	40	75	35

Table 1.2: Height growth of oak and pine seedlings in open and undercanopy microsites at eroded site.

	Oak		**Pine**	
	Open	**Undercanopy**	**Open**	**Undercanopy**
Initial height (cm)	7.5±.051	8.5±.026	12.0±.062	12.4±.059
Height increment (cm)				
First year	4.8	11.2	4.6	9.1
Second year	-	14.5	5.9	10.8
% height increment				
Spring	-	56	44	51
Summer	-	15	18	18
Rainy	-	29	32	28
Rate of height growth (cm d^{-1})	-	0.059	0.024	0.044

Table 1.3: Stem diameter growth of oak and pine seedlings in open and undercanopy microsites at eroded site.

	Oak		**Pine**	
	Open	**Undercanopy**	**Open**	**Undercanopy**
Initial diameter (mm)	3.45	3.59	2.92	2.61
Diameter increment (mm)				
First year	1.86	2.65	1.22	1.11
Second year	-	2.72	2.94	2.77
% diameter increment				
Spring	-	26	22	29
Summer	-	15	16	23
Rainy	-	59	61	48
% shrinkage	-	1.9	4.2	3.2
Rate of diameter growth (mm d^{-1})	-	0.003	0.007	0.006

Table 1.4: Leaf characteristics of oak seedlings in open and undercanopy microsites at eroded site.

Leaf characteristics	Open	Undercanopy
Leaf number at the time of plantation	9.5	8.9
Peak leaf pool size	-	23.9
% leaf recruitment		
Spring	-	65
Summer	-	11
Rainy	-	25

Table 1.5: Leaf area (cm^2 $leaf^{-1}$) of oak seedlings at open and undercanopy microsite at eroded site.

Leaf area	Open	Undercanopy
Beginning of leaf expansion	-	April
End of expansion	-	May
Expansion period (days)	-	46
Leaf area at full expansion	-	16.8
(cm^2 $leaf^{-1}$)	-	0.36
Rate of leaf expansion (cm^2 d^{-1})		

References

1. Barton, A.M. 1993. Factors controling plant distributions: drought, competition, and fire in montane pines in Arizona. Ecological Monographs 63: 367-397.

2. Callaway, R. M., N. M. Nadkarni, B. E. Mahall. 1991. Facilitation and interference of Quercus douglassi on understorey productivity in Central California. Ecology 72: 1484-1499.

3. Chen, J., J.F. Franklin, and T.A. Spies. 1995. Growing season microclimate gradients from clearcut edges into old-growth Douglas-fir forests. Ecological Applications. 5: 74-86.

4. Clement, F.E. 1916. Plant succession: An analysis of the development of vegetation. Caregien Institution of Washington, Washington, DC.

5. Dhaila, S. 1991. Phenology of deciduous and evergreen broadleaf species with particular reference to water stress. Ph. D. Thesis, Kumaun University, Nainital. India.

6. Franco- Pizana, J; Fulbright, T. E. and Gardiner, D. T. and Tipton, A. R. 1995. Spatial relations between shrubs and Prosopis Glandulosa canopies. J. Veg. Sc. 6: 73-78.

7. Gill, D. S. and Mahall, B. E. 1986. Quantative phenology and water relations of an evergreen and a deciduous chaparral shrub. Ecological Monographs 56: 127-143.

8. Goldfellow, M. and S. T. Williams. 1985. Ecology of Actinomycetes. Ann. Rev. Microbiol. 37: 189-216.

9. Holmgren, M.; Scheffer, M. and Huston, M. A. 1997. The interplay of facilitation and competition in plant communities. Ecology 78: 1966-1975.

10. Joffre, R. and Rambal, S. 1988. Soil water improvement by trees in the rangelands of Southern Spain. Oecol. Pl. 9: 405-422.

11. Miller, T. E. 1994. Direct and indirect species interactions in an early old field plant community. Amer.Naturalist.143:1007-1025.

12. Mitchell, W. W. 1987. Revegetation research on coal mine overburden materials in interior to South-eastern Alaska. Agriculture and Forest Experimental station Bulletin 79: 72-86.

13. Mooney, H. A. and Billings, W. D. 1961. Comparative physiological ecology of arctic and alpine populations of Oxyria digyna. Ecological Monographs 31: 1-29.

14. Morris, W. F. and Wood D. M. 1989. The role of lupine in succession on Mount St. Helens: Facilitation or inhibition? Ecology 70: 697-703.

15. Ralhan, P. K., Khanna, R. K., Singh, S. P. and Singh, J. S. 1985a. Certain phenological characters of the tree layer of Kumaun Himalayan forests. Vegetatio 60: 91-101.

16. Ralhan, P. K., Khanna, R. K., Singh, S. P. and Singh, J. S. 1985b. Certain phenological characters of the shrub layer of Kumaun Himalayan forests. Vegetatio 63: 113-120.

17. Singh, J. S. and Jha, A. K. 1983. Restoration of degraded land: an overview. In: J.S. Singh (ed.) Restoration of degraded land: Concepts and Strategies. Rastogi Publication, Meerut, India.

18. Sylvester, W.B. 1983. Analysis of nitrogen fixation. In: Biology of nitrogen fixation in forest ecosystems (eds. J. C. Godon and C. T. Wheeler) pp. 173-212, Martinus Nijhoft, The Hague. The Netherlands

19. Vetaas, O. R. 1992. Microsite effects of trees and shrubs in dry savannas. Journal of Vegetation Science 3: 337-344.

20. Singh, S.P. Ralhan, P.K., Upadhyaya, V.P. and Negi, G.C.S. 1990. Seasonal changes in stem diameter and leaf development in a tropical montane forests. Journal of vegetation Science 1: 165-172.

ACKNOWLEDGEMENT

Financial support from C.S.I.R. New Delhi is gratefully acknowledged.

Corresponding address: Dr. Deepti Goel, D/o Shri S.R. Prasad, LIG-71, Awas- Vikas, Haldwani, Nainital-263139 (Uttarakhand)