Original Article

Bulletin of Environment, Pharmacology & Life Sciences
Volume 1, Issue 3, February 2012: 55 - 57
Journal's URL: www.bepls.com
Online ISSN 2277-1808
[Received 12 January 2012; Revised 27 January; Accepted 24 February 2012]

Effect of Spatial Distribution on the Growth Performance of *Leucaena leucocephala* Planted on Coal Mine Spoil

Arvind Singh
Department of Botany
Banaras Hindu University, Varanasi-221 005, India
E-mail:arvindsingh_bhu@yahoo.com; Phone : +91 542 2316310;
Fax : + 91 542 2366708

ABSTRACT

A study was undertaken in Jayant coal mine of Singrauli coalfields, India to analyze the growth performance of tropical leguminous tree Leucaena leucocephala planted with two different row spacing distance on coal mine spoil. It was evident from the study that row spacing distance had marked impact on the growth performance of Leucaena leucocephala. Saplings planted with (2 x 4 m) distance exhibited better growth than those planted with (2 x 2 m) distance.

Key words : *Height increment, diameter increment, Leucaena leucocephala mine spoil, row spacing distance, volume increment*

INTRODUCTION

Mine spoil consists of overburdened dumps of haphazardly consolidated and unconsolidated materials. Mine spoils are nutritionally and microbiologically impoverished habitats [1, 2]. Natural restoration of mine spoil is a slow process [3, 4]. Afforestation of mine spoil with leguminous tree species accelerates the revegetation process and fulfils the restoration goal. *Leucaena leucocephala* (Lam.) de Wit is a fast growing exotic tree species native to Central America and Pacific islands. The tree species was chosen for the afforestation of mine spoil due to its high nitrogen fixing ability, fast growth and wide range of adaptability (adapts well to a wide range of tropical and sub-tropical environments, especially seasonally dry tropical areas). The performance of planted tree depends on the spacing distance. Several studies have been conducted to explore the influence of spacing distance on growth performance
and biomass production in different tree species including *L. leucocephala* [5-11]. The evaluation of spacing distance is essential for maximum growth and yield under short period of time. Therefore the present study was aimed to explore the impact of the row spacing distance on growth performance of *L. leucocephala* on coal mine spoil.

MATERIAL AND METHODS

Site description

The study was conducted at Jayant coal mine in the Singrauli coalfields, India. The Singrauli coalfields extends over an area of more than 2200 km^2 (23^{o}47$'$ – 24^{o}12$'$ N 81^{o}48$'$ – 82^o 52$'$ E and elevation of 280-519 m above mean sea level), of which 80 km^2 lie in Uttar Pradesh and the rest is in Madhya Pradesh. The climate is tropical monsoon with temperature reaching up to 48^{o}C during June and lowering down to 5^{o}C in January. Rainfall varies from 900 to 1000 mm during monsoon months of June to September. The potential native vegetation is a tropical dry deciduous forest. The texture of the spoil material was 80% sand, 10% silt, and 10% clay, with a pH of 7.4, total N 0.018% and total P 0.010% [12]. Soil cores to a depth of 10 cm consisted of 75% of particles greater than 2 mm in diameter.

Experimental design and methods

Nursery raised 1-year-old saplings of *L. leucocephala* were planted on fresh mine spoil in July 1993. The saplings were planted in 20 m x 20 m plots at two different row spacing distance i.e. 2 m and 4 m. The within row spacing distance was 2 m. Thus the spacing distance was 2 x 2 m (smaller row spacing distance) and 2 x 4 m (bigger row spacing distance). Three replicate plots were maintained for both the row spacing distance which was part of the same overburden dump. The idea behind 4 m row spacing distance was to raise the non-leguminous crop *Pennisetum typhoides* between rows of *L.*

leucocephala saplings. However, the seeding of *P. typhoides* could only be done in the year 1994.

A total of 9 individuals distributed equally between the three replicate plots were selected at random for growth measurements for both the row spacing distance planted saplings of *L. leucocephala*. Height and diameter measurements were made in April 1996 (33 months after plantation) and in December 1997 (53 months after plantation). Diameter (*d*) was measured at 20 cm above the ground surface. Height (*h*) was measured using a scaled bamboo stick.

Volumes of tree (*V*) were calculated as a cone ($V = d^2h$) which frequently figures as a proxy variable for biomass [13, 14]. Tree growth was assessed as increments in height, diameter and volume from the value measured in April 1996 and December 1997. Annual increments of the above variables were calculated from the differences between the two measurements. Differences between row spacing distance means were tested for significance through a two-tailed Student's *t*-test [15].

RESULTS AND DISCUSSION

The values of height, diameter and volume of *L. leucocephala* planted at two different row spacing distance are presented in Table 1, while values of height, diameter and volume increments are depicted in Table 2. The study reveals marked effect of row spacing distance on growth performance of *L. leucocephala* on coal mine spoil. Height, diameter and volume for both the ages were significantly greater in saplings planted at bigger row spacing distance. At first measurement (33 months after plantation), height, diameter and volume were 113.6%, 179.5% and 1712%, respectively greater at bigger row spacing distance planted saplings compared to smaller row spacing distance planted saplings. Similarly at second measurement (53 months after plantation) the height, diameter and volume growth were 120%, 99.34% and 899%, respectively greater in the saplings planted with bigger row spacing distance. Spacing distance affects the diameter and biomass production in *L. leucocephala* [10]. The reduced growth in saplings planted at smaller row distance may be due to increased competition for resources like light, nutrients and water. Since mine spoils are poor in nutrients, organic matter and moisture consequently there would be increased competition between the individuals.

Table 1: Height, diameter and volume of *Leucaena leucocephala* at two different age, planted on mine spoil at two different row spacing distance

Row spacing distance	33 months after plantation			53 months after plantation		
	Height (m)	Diameter (cm)	Volume (d^2h) (cm^3)	Height (m)	Diameter (cm)	Volume (d^2h) (cm^3)
2 m	2.50 ± 0.15[a]	2.83 ± 0.28[a]	2224 ± 451[a]	3.84 ± 0.20[a]	6.11 ± 0.31[a]	15248 ± 2048[a]
4 m	5.34 ± 0.27[b]	7.91 ± 1.00[b]	40295 ± 10787[b]	8.45 ± 0.46[b]	12.18 ± 1.54[b]	152300± 41846[b]

Mean ± 1 S.E.

Values in a column suffixed with different letters are significantly different from each other at $P < 0.05$.

Table 2: Annual height, diameter and volume increments of *Leucaena leucocephala* planted on mine spoil at two different row spacing distance

Row spacing distance	Height increment (m)	Diameter increment (cm)	Volume increment (cm^3)
2 m	0.84 ± 0.03[a]	1.97 ± 0.13[a]	7814 ± 1009[a]
4 m	1.86 ± 0.12[b]	2.55 ± 0.32[a]	67203 ± 18656[b]

Mean ± 1 S.E.

Values in a column suffixed with different letters are significantly different from each other at $P < 0.05$.

The annual height and volume increments were significantly greater in saplings planted with bigger row spacing distance compared to the saplings planted with smaller row spacing distance. However, the

difference was not significant for diameter growth rate. This suggests that the row spacing distance had little effect on annual diameter growth rate. The height, diameter and volume increments were 121.42%, 29.44% and 760.03%, respectively greater in saplings planted with bigger row spacing distance than saplings planted with smaller row spacing distance. The height and diameter growth rate in *L. leucocephala* increases with increasing row spacing distance but decreases with age [8]. The annual height and volume increments for *L. leucocephala* planted at the row spacing distance of 2 m was in range as reported for other leguminous tree species planted with same spacing distance in monoculture and mixed culture plantations on coal mine spoil [16, 17]. However, large variation was reported for diameter increment.

The study also reveals that impact of row spacing distance was greater for volume and annual volume growth rate in *L. leucocephala*.

CONCLUSION

It can be concluded from the study that the row spacing distance had affected the growth and volume (proxy variable for biomass) of *L. leucocephala* on nutrient deficient mine spoil. The saplings planted with bigger row spacing distance had greater growth and volume than smaller row spacing distance planted saplings.

REFERENCES

1. Wali, M. K. (1975). *Practices and Problems of Land Reclamation* in *Western North America*, University Grand Forks : North Dakota Press, 1-17.
2. Singh, J. S. and A. K. Jha (1993). Restoration of degraded land : an overview. In : Singh, J. S. ed. *Restoration of Degraded Land Concepts and Strategies*, Rastogi Publications, Meerut, India, pp. 1-9.
3. Jha, A. K and J. S. Singh (1991). Spoil characteristics and vegetation development of an age series of mine spoils in a dry tropical environment. *Vegetatio* **97 :** 63-76.
4. Jha, A. K and J. S. Singh (1992). Influence of microsites on redevelopment of vegetation on coal mine spoils in a dry tropical environment. *J. Environ. Manage.* **36** : 95-116.
5. Niemistoe, P. (1995). Influence of initial spacing and row-to-row distance on the growth and yield of silver birch *(Betula pendula)*. *Scandinavian J. For. Res.* **10**(3) 245-255.
6. Xie, C. Y., W. D. Johnstone and C. C. Ying (1995). Spacing and Provenenance effects on the performance of shore pine *(Pinus contortus)* : 20 years test results. *Canadian J. For. Res.* **25** (4) : 267-576.
7. Temeche, W. A. (1999). Biomass production and nutrient dynamics of *Eucalyptus tereticornis* planted at different density. *M Sc. Thesis*, Nauni, Solan, India.
8. El-Juhany, L. I. and M. A. Ibrahim (2001). Spacing effects on relative growth rates of height, diameter and biomass production of *Leucaena leucocephala* (Lam.) de Wit. Before and after planting. *Meteorology, Environ. Arid Land Agri. Sci.* **12** : 77-87.
9. Bhardwaj, S. D., P. Panwar and S. Gangam (2001). Biomass production potential and nutrient dynamics of *Populus deltoides* under high density plantation. *Indian For.* **17** : 144-153.
10. Prasad, J. V. N. S., G. R. Korwar, K. V. Rao, K. Srinivas, C. A. Rama Rao, C. H. Srinivas Rao, B. Venketeshwarlu, S. N. Rao and H. D. Kulkarni (2010). Effect of modification of tree density and geometry on intercrop yields and economic returns in Leucaena- based, agro-forestry systems for wood production in Andhra Pradesh, Sourthern India, *Experiment. Agri.* **46** (2) : 155-172.
11. Kumar, S., R. Kumar and N. Kumar (2011). Effect of spacing on biomass production, nutrient content and uptake by poplar *(Populus deltoides)* plantation. *Indian J. Forestry* **34** (2) : 157-160.
12. Singh, A. (1999). *Revegetation of Coal Mine Spoil : Influence of Nutrient Amendment and Neighbouring Species on Growth Performance and Foliar Nutrient Dynamics of Woody Species,* Ph.D. Thesis, Banaras Hindu University, India.
13. Zavitkovski, J. and R. D. Stevens (1972). Primary Productivity of red alder ecosystems. *Ecol.* **53** : 235-242.
14. DeBell, D. S., C. D. Whitesell and T. H. Schubert (1989). Using N-fixing *Albizia* to increase growth of *Eucalyptus* plantations in Hawaii. *For. Sci.* **35** : 64-75.
15. Snedecor, G. W. and W. G. Cochran (1968). *Statistical Methods*, Oxford and IBH Publishing Co., New Delhi, India.
16. Singh, A. and J. S. Singh (2001). Comparative growth behaviour and leaf nutrient status of native trees planted on mine spoil with and without nutrient amendment. *Ann. Botany* **87 :** 777-787.
17. Singh, A. (2006). Growth and leaf nutrient status of companion species as influenced by neighbouring species in mixed plantations raised on mine spoil. *Trop. Ecol.* **47**(2): 259-269.