Effect of Different Sand and Soil Ratios on the Growth of *Terminalia arjuna* W. & A.

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Abstract: The present work was aimed to determine the suitable soil condition for the growth of the medicinal plant Terminalia arjuna W. & A. The phenological attributes of the Terminalia arjuna were studied for different parameters viz., whole length, stem length, root length, whole biomass, stem biomass and root biomass. Preparation of soil sample was done following the procedure of drying, grinding, sieving, mixing and partitioning. Seeds of Terminalia arjuna were sown in two sand and soil ratios (80 sand: 20 normal soil, 40 sand: 60 normal soil) and a control condition (normal soil). The data were analyzed by using factorial analysis (GENSTAT 5). The results of present study showed that root biomass in control condition was higher (2.74 gm) than in other two types of soil ratio (1.63 gm for 80:20 and 1.44 gm for 40:60). It was observed that stem biomass in soil ratio of 40:60 was higher (2.87 gm) than other two soil ratios (2.45 gm and 2.42 gm) the whole length of plant was highest (141.8 cm) during rainy season followed by summer (74.8) and winter (43.5). The root length of the plant was highest (66.0 cm) in rainy season and minimum (25.5 cm) in winter season. The findings suggested that Terminalia arjuna gave better growth pattern in the soil ratio of 80:20 in rainy season. [New York Science Journal 2010;3(11):22-26]. (ISSN: 1554-0200).

Keywords: Phenology, Terminalia arjuna, Medicinal plant

1. Introduction

India has one of the oldest, richest and most diverse cultural traditions associated with the use of medicinal plants. It represents a striking example of the intimate link between biodiversity and cultural diversity (Shankar and Ved, 2003). *Terminalia arjuna*, a great medicinal valuable plant is a large tree with smooth and thick bark belongs to the family Combretaceae. The tree is found throughout the greater parts of India. Arjuna is reported as a good cardiac tonic and is useful in blood dysentery, blood pressure, fractures of bones, heart diseases, leucorrhoea and earache, and acts as an antidote to poisons.

The continued commercial exploitation has resulted in receding population of medicinal plant in their natural habitat, potentially creating storage of the raw plant materials required extensively by the pharmaceutical industry and the traditional practitioners. Therefore, the cultivation of these plants is needed to ensure a dependable, continued supply. Since in-situ conservation of these resources alone can not meet the ever-lasting demand of the pharmaceutical industry, the development of cultural practices and propagation methods for these plants in suitable agro-climatic regions are necessary.

The soil properties have been a subject of great interest in forestry. The composition of soil is subject to constant changes, caused by the growth of trees and ground cover vegetation, activity of organisms and effects of climatic agents. Under the influence of these factors, minerals and organic remains, undergo gradual decomposition or disintegration. Within each of such zones local conditions and topography, drainage, parent material and forest cover give rise to a definite association of individual soil types in order to better growth of plants. The nature of organic debris returned to the forest floor varies in the vegetation and affects the physico-chemical properties of the soil. On the other hand, vegetation due to its close canopy protects the soil from the direct impact of rain drops, which results in reduced soil erosion and increase in soil moisture.

Soil texture is an important modifying factor in relation to the proportion of precipitation that enters the soil and becomes available to the plant. Clay holds maximum moisture per unit volume and provides moisture for tree growth, while sandy soil holds less moisture per unit volume but permits more rapid percolation of precipitation water than clay. Sandy-loam to sandy soils was the most suitable soil condition found in *Dalbergia sissoo* growth (Jacson,

1987). Therefore the present work was aimed to determine the suitable soil condition for the growth of *Terminalia arjuna.*

2. Material and Methods

2.1. Preparation of soil sample: Preparation of soil sample involved procedure of drying, grinding, sieving, mixing and partitioning. Seeds of Terminalia arjuna were sown in two sand and soil ratios and a control condition, which were as follows:

1. 80:20 (Sand : Normal Soil)
2. 40:60 (Sand : Normal Soil)
3. Control condition (Normal Soil)

The ratios of sand and soil were made by their volumes. In control condition there was no addition of sand. For all the three types the soil was collected from the garden of the Govt. Post Graduate College, Rishikesh and then it was mixed with virgin sand.

2.2. Mechanical analysis of soil: The separation of the sand, silt and clay particles was done by Pipette Method using the following calculations:

$$(\text{Silt} + \text{clay})\% = \frac{\text{Weight of ignited (silt + clay X 1,000 X 100)}}{\text{Wt. of soil sample taken x Amount of solution out}}$$

$$\text{Clay } \% = \frac{\text{Weight of ignited X 1,000 X 100}}{\text{Wt. of soil sample taken X Amount of solution pipette out}}$$

$$\text{Sand } \% = 100 - (\text{Silt} + \text{clay}) \%$$

2.3. Soil organic matter: Determination of organic matter content as organic carbon (OC) content is most widely used. The organic matter content was determined by Walkely and Black's Rapid Titration method (1934).

2.4. Nitrogen: The method of determination of nitrogen involves conversion of all the nitrogen of soil in ammonical form and absorbing the latter in some standard acid and then titrating with standard to know the amount released. Kjeldahl method was used for soil nitrogen determination.

2.5. Available potassium: It was estimated using Flame photometer.

2.6. Soil reaction or pH: Soil reaction or pH was analyzed by Universal Indicator Method.

2.7. Cultivation practices: The phenological attributes of the Terminalia arjuna were studied with different parameters viz., whole length, stem length, root length, whole biomass, stem biomass and root biomass (Misra, 1968). The data were analyzed as factorial analysis (GENSTAT 5). The two factors or say sources of variations were the seasons and the soil ratios. The standard errors of means and least significant differences of means were also estimated to compare the effects of different seasons and soils on the studied parameters. The correlation coefficients between various parameters were also estimated.

2.8. Steps for Cultivation Practices: The seeds of Terminalia arjuna were collected from Prem Nursery, Dehradun and Sushila Tiwari Herbal Garden, Muni Ki Reti, Tehri Garhwal. The sowing of the seeds was made in the month of April according to sowing period of this species. The seeds were sown in the small polybags at the depth of 5 cm. The germination time was recorded after their sowing date. After germination of the seeds, the data was recorded after every two months. Three plants (replicates) were uprooted after every two months, and then washed with tap water to remove their soil and sand particles with proper handling. Different phenological data were recorded. Root and stem were separated for the biomass estimation. Each part was wrapped in a paper and kept in the oven to dry its moisture. The root and stem were weighed for the biomass production after drying.

3. Results

3.1. Analysis of Experimental Soil

The value of pH for the soil ratio of 80:20 was 7.52, whereas for ratio of 40:60 it was found 7.55 and for control condition it showed the value of 7.52.The value of OC (%) was found to be highest (2.62 %) for control condition, however for the ratio of 40:60 it was recorded as 2.06, and for ratio of 80:20 it was 1.04 %. The value of organic matter was found 4.52, 3.52 and 1.79 % for control, 40:60 and 80:20 soil ratios respectively. The value of N (%) was found to be highest (0.62 %) for the soil ratio of 40:60 (Sand: Soil), however it was 0.030 % for control condition, and 0.023 % for 80:20 ratio of sand and soil. The percentage of P for all three types of soil was found to be highest (0.007 %) for control condition, whereas 80:20 ratio showed lowest value (0.003 %). For ratio of 40:60 the P was 0.005 %.The soil ratio of 80:20 showed the lowest (0.009 %) percentage of K, however control condition showed highest value (0.03

%). The soil ratio of 40:60 recorded 0.007 % of K. (Table 1).

Table1. Chemical properties of the experimental soil

Soil ratio	K (%)	OC (%)	OM (%)	N (%)	P (%)
80:20	0.009	1.04	1.79	0.023	0.003
40:60	0.007	2.06	3.52	0.062	0.005
Control	0.03	2.62	4.52	0.03	0.007

The textural class has been determined on the basis of the sand, silt and clay percentages. For the soil ratio of 80:20 the percentage of sand, silt and clay was 85, 8 and 7 % respectively which indicated sandy loam texture. The percentage of sand, silt and clay was 65, 19, and 16 % respectively for the sand and soil ratio of 40: 60 which showed loamy texture. For the control condition the ratio of sand, silt and clay was 48, 32 and 20 % respectively with the texture of silty clay (Table 2).

Table 2. Soil pH and physical properties of the experimental soil

Soil artio	pH	Sand	Silt	Clay	Textural class
80:20	7.52	85%	8%	7%	Sandy loam
40:60	7.55	65%	19%	16%	Loamy
Control	7.52	48%	32%	20%	Silty clay

3.2. Effect of soil and seasons on the phenological characters: The analysis of whole length of *Terminalia arjuna* revealed that variation among seasonal values was highly significant. The whole length of plant was highest (141.8 cm) during rainy season followed by summer (74.8) and winter (43.5). It indicated that rainy season was most favourable season for whole length of the plant. For soil ratio of 80:20, plant showed better results (93.5 cm) than remaining soil types (86.9 cm for 40:60 and 85.1 cm for control condition) (Table 2, Fig.1).The whole length of the plant seems to have significant influence on many growth parameters as the correlation between them was highly significant (Table 3).

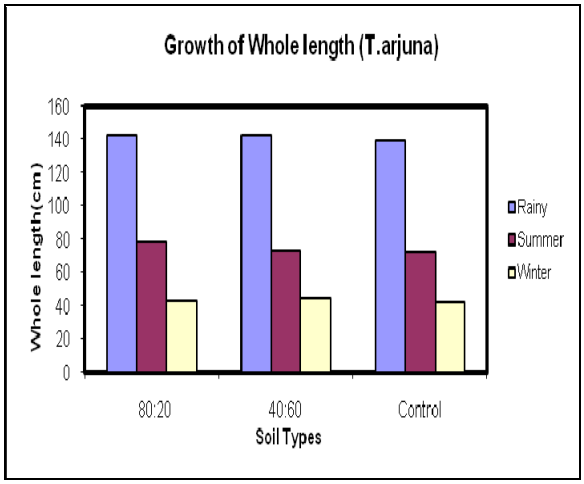

Figure 1. Effect of different soil ratios and seasons on the growth of *Terminalia arjuna*

The analysis of root length revealed that it varied significantly with seasons. The root length of the plant was highest (66.0 cm) in rainy season and minimum (25.5 cm) in winter which indicated that like whole length, root also showed best results in rainy season whereas in winter it was very slow. The soil types did not show any significant variations. However the maximum value (70.5 cm) was found for control condition. For the growth of root the differences among seasons were very prominent. The stem length of plant was found to be maximum (70.1) in rainy season and minimum in winter (16.9).

The soil types also differed significantly in stem length. The soil ratio of 40:60 gave significantly higher stem values (45.4 cm) than control condition (34.3 cm) and the soil ratio of 80:20 (33.5 cm).The interaction between soil type and season showed that during rainy season both the soil ratios (80:20 and 40:60) worked significantly better as compared to summer and winter. It was also observed that all soil types had been ineffective in winter season. The stem length of plant was significantly correlated with the different growth parameters.

3.3. Biomass production: It was seen that the average root biomass due to different soil types used in the experiment differed significantly. It was observed that plant's root biomass in control condition was higher (2.74 gm) than in other two types of soil ratios (1.63 gm for 80:20 and 1.44 gm for 40:60). The root biomass of plant varied significantly with seasons. It was found to be very high (4.67 gm) in rainy season and that in summer and winter it was very low (0.98 gm and 0.17 gm respectively). Root biomass was also found to be significantly correlated with all growth parameters.

The findings of stem biomass of plant were quite similar in pattern to root biomass analysis. These also varied significantly with seasons. It was higher in rainy season (6.73 gm) and minimum in winter (0.18 gm). The average stem biomass due to soil types did not differ significantly. It was observed that stem biomass in soil ratio of 40:60 was higher (2.87 gm) than other two soil ratios (2.45 gm and 2.42 gm) (Table 3).

Table3. Effect of different soil types and seasons on the growth of *Terminalia arjuna*

Parameters		WL (cm)	RL (cm)	SL (cm)	RB (gm)	SB (gm)
Season	Rain	141.8	66	70.1	4.67	6.73
	Winter	43.5	25.5	16.9	0.17	0.18
	Summer	74.8	49	26.1	0.98	0.83
	CD	*11.2**	*10.4**	*6.51**	*0.8***	*1.1***
Soil Type	(80:20)	88.1	50.8	34.3	1.63	2.45
	(40:60)	86.9	41.4	45.4	1.44	2.87
	(Control)	85.1	48.4	33.4	2.74	2.42
	CD	*NS*	*NS*	*6.5***	*0.82**	*NS*

Significant at 1% Probability level, *
Significant at 0.1% Probability level, NS – Non-Significan

4. Discussion: Phenology is the scientific study of seasonal changes i.e., periodic phenomena of organisms in relation to their climate. Different species have different periods of seed germination, vegetative growth, flowering, fruiting, leaf fall, seed and fruit dispersal etc. Phenological changes in species and their number of individuals may not only be seasonal occurrence but they may also vary from year to year (Muller-Dombois and Ellenberg, 1974).

Within the three soil conditions *Terminalia arjuna* responded in different manner. It gave better growth pattern for the soil ratio of 80:20. The pH was highest in the case of 80:20 ratio with the lowest value of clay (7%).The higher the amount of the clay in the soils, lower is the pH value. In other words, soil acidity increases with an increase in the clay content in the soil. However sand and silt did not show any significant correlationship with the pH of soil (Sah et. al., 2003). Control condition appeared as a casual factor of reduced growth for this species. Waterlogging caused by higher amount of clay could be one of the causal factors for the reduced growth. Higher clay and silt contents reduce the growth of plant (Sah et al., 2003).

Srivastava and Behl (2002) also studied the growth of *Terminalia arjuna* in different types of soil and farm yard manure potting media. There was a sustainable increase in seedling biomass in sandy loam soil. They concluded that *Terminalia arjuna* seedlings had a modest potential to tolerate alkalinity and could attain optimum growth under stress of nutrient availability. For 80:20 ratio of soil the nutrients were lowest as compared to other soil conditions, although it showed higher pH value (7.60) with the lowest value of clay percentage (7%).

Among the seasons winter showed poor growth for all the species. The factor responsible for this may be expressed as the extreme water stress from the outside atmosphere due to fog or frost conditions, which reduces the plant growth although plants can absorb some fog water directly through leaf and recover water balance (Zheng and Feng, 2006).

The reduced growth of *Terminalia arjuna* was observed in the season of winter for the soil ratio of 80:20. It has been concluded that 80:20 soil ratio in the winter season did not have favorable affects on this species. Reduced leaf area due to water stress has been observed by Singh and Singh (2007). Reduction in growth rate at severe water stress has also been reported by Paulilo et al. (1998) for *Eucaylyptus grandis.* The root and stem were found equally dominant to each other in the case of *Terminalia arjuna* Thus, the soil texture and nutrients equally affect the stem and root growth.

In *Terminalia arjuna* root biomass production was found least in control condition under different treatments (Singh, 2004). In present study the whole length was in positive agreement with all the parameters. This implies that all these parameters supported the plants in the same manner. For stem/root ratio, root length showed negative correlation (-0.350). The reason was quite obvious that with the increase of stem /root ratio the value of root should be decreased. Coefficient analysis, though frequently used in agricultural crops has been rarely applied in tree species (Jindal et al., 1987; Khosla et al., 1985; Siddiqui et al., 1993). Kumar and Parmathama (2005) persuade the interrelation between twelve independent characters and found positive and significant interrelation among them.

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