Madras Agri. J., 88(4-6) : 287 - 290 April - June 2001
https://doi.org/10.29321/MAJ.10.A00340

Effect of soil reaction and organic matter on germination and seedling vigour of Babul (*Acacia nilotica* Linn.)

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Abstract : An experiment was conducted to find out the effect of different soil pH along with nursery mixture on germination, seeding vigour and chemical attributes of *Acacia nilotica* at Agricultural Engineering College and Research Institute, Kumulur, Tiruchirappalli during February 1999. The seeds were sown in soil with different pH (8.1, 9.0, 10.2 and 10.5) and the differential pH soil mixed with sand + farm yard manure (2:1:1 ratio) compared with control (red earth + sand + farm yard manure 2:1:1 ratio). The result revealed that *Acacia nilotica* has a wider range of adaptability in relation to pH. The species is able to tolerate extreme soil pH of 10.5, when the soil is mixed with sand and farm yard manure at 2:1:1 ratio, in terms of germination, seedling growth and chemical attributes of the seedlings. *(Key words : Acacia nilotica,* Soil reaction, Germination, Seedling vigour).

Acacia nilotica is an important multipurpose tree and gives very strong, tough and heavy timber which is nearly twice as hard as teak. It grows in all the types of soil, in areas having pH < 7.9 under poor drainage conditions and also tolerates seepage of high water table at a soil depth of 2-3 m (Singh and Jha, 1990). Seed germination is affected by a number of environmental factors, of which one is pH (Parihar *et al* 1984; Munns and Termaat, 1986, Roy 1986 and Sharma *et al,* 1998). These studies have shown that relationship between germination and pH varies considerablywith seeds of different crops and grass plants, where as woody perennials have been little studies. Establishment of tree plantation in salt affected soil results in ameliorative process by favourable effect on physical, chemical and biological properties of soil. Determination of salt tolerance of tree species for plantation of such sites, especially during establishment and early stage of growth, when the plants are too tender to bar inhospitable soil conditions (Sharma *et al.* 1998). Such studies on *Acacia nilotica* were reported by Chaturvdi (1955) and Luna (1996). Whereas study on germination and juvenile growth influence on soil pH are very few. Hence, the present investigation was undertaken to study the effect of soil reaction and organic matter on germination and seedling vigour of *Acacia nilotica.*

Materials and Methods

Matured pods of Acacia were collected from 10 year old stands in Agricultural Engineering College and Research Institute campus, Kumulur, Tiruchirappalli, Tamil adu (10°4' N; 78°5 E; 70 m.a.s.l.) and the seed were extracted by manual shelling, and they were cleaned and subjected to scarification with commercial sulphuric acid 200 ml kg^{-1} of seed for 25 min. (Rajasingh, 1987). Acid scarified seeds were washed and dried back to original moisture content of 9.3%. The soil samples of varying pH were collected from Agricultural College and Resarch Institute, Trichinappalli and Manikandam block of Tiruchirappali district and sieved. These sieved soil samples were analysed for chemical properties viz. pH, cation exchange capacity (C.mol.$p^{+}kg^{-1}$),exchangeable sodium percentage (ESP) and electrical conductivity (EC) of the soil (dSm^{-1}). The seeds were sown in polythene bags (size 13 cm x 25 cm) filled with different nursery media viz. red earth +sand + farm yard manure at 2:1:1 ratio (T_1), soil pH 8.1 (T_2), soil pH 9.0 (T_3), soil pH 10.2 (T_4), soil pH 10.5 (T_5), soil pH 8.1 + sand + farm yard manure at 2:1:1 ratio (T_6), soil pH 9.0 + sand + farm yard manure at 2:1:1 ratio (T_7), soil pH 10.2 + sand + farm yard manure at 2:1:1 ratio (T_8) and soil pH 10.5 + sand + farm yard manure at 2:1:1 ratio (T_9). T_1 was considered as control. The trial was set up in completely randomized design (RBD) with 200 seeds sown in each treatment and replicated four times. On 28 days after sowing, the germination (ISTA 1985) was counted and the percentage germination was computed. Ten random seedlings were dried in a hot air oven at 85°C for 24 hr and the dry weight was recorded. Vigour index was calculated as the product of germination percentage and seedling length (Abdul Baki and Anderson, 1973). When the seelings were 180 days old, the seedling attributes viz. survival (%) root length (cm), shoot length (cm), numbr of leaves $seedling^{-1}$, root collar diameter (cm), root and shoot dray weight (g) and leaf area (cm^2) and biochemical attributes viz. chlorophyll content - a, b and total ($mg\ g^{-1}$) and total N (%), P (%) and K (%) content were estimated. The data were subjected to analysis of variance as per Panse and Sukhatme year (1978) and tested for the significance of variance (P = 0.05 per cent) and mean values were compared using Duncan's Multiple Range Test (Gomez and Gomez, 1984)

Results and Discussion

The pH of the experimental soils ranges from 8.1 to 10.5 (slightly alkaline to strong alkaline). The CEC was increased from 18.4 to 23.8, as the soil pH increased from 8.1 to 9.0. There was a reduction in CEC i.e. 15.7 and 14.5 for soil pH of 10.2 and 10.5 respectively. The exchangeable sodium percentage (ESP) was 11.8 for 8.1 soil pH, 21.4 for 9.0 soil pH, 45.8 for 10.2 soil pH and 49.5 for 10.5 soil pH. The EC was 0.18 dSm^{-1} for 8.1 soil pH. after that, there was no much varation in EC.

The effect of soil pH and organic matter on germination and initial seedling vigour of *Acacia nilotica* is given in Table1. The results revealed that 100 per cent germination was observed with T_3 treatment (soil pH of 9.0) followed by T_2 and T_1 treatment (99.0 per cent). The lowest germination of 95.0 per cent was recorded with T_9 treatment, where the seeds were sown in soil with a pH of 8.1 + sand + farm yard manure at 2:1:1 ratio. Similar results have been reported by Srinivasu and Toky, (1996) in *Acacia nilotica, Albizia lebbeck, Pithecellobium dulce* and *Prosopis juliflora* in an alkalinity range of pH 8.5 - 11.0. The presence of large amount of soluble salts in the soil retards germination mainly because water cannot easily enter the germinating seed due to high osmotic pressure. Some salts are also directly toxic to the germinating seeds and young seedlings (Daji, 1992). The highest root length of 11.2 cm and shoot length of 12.1 cm was observed with T_3 treatment (soil pH of 9.0). There was a reduction in root and shoot length as the soil pH increased from 9.0 to 10.5. Regarding drymatter production, the treatment T_2 where the seeds were sown in the soil of 8.1 pH. There was a slight decrese in dry matter production as the pH of soil increased from 8.1 to 10.5. When these alkaline soil was mixed with sand and farmyard manure, there was a slight improvement in drymatter production. The highest vigour index of 2325 was recorded with the soil of 9.0 pH, which was on par with the normal nursery mixture of red earth + sand + farm yard manure at 2:1:1 ratio (2064) and the soil with a pH of 10.2 + sand + farm yard manutre at 2:1:1 ratio (2062).

When the seedlings were 180 days old, the seedling attributes viz. survival percentage, root length, shoot length, number of leaves seedlings, root collar diameter, root dry weight, shoot dry weight and leaf area were recorded and the results are presented in Table-2. The results revealed that the highest survival percentage of 99.4 was recorded with control (T_1) which was on par with all other treatments except T_5 and T_4. The survival percentage was the lowest (92.4 per cent) with T_5 (soil with a pH of 10.5). When it was mixed with sand and farmyard manure at 2:1:1 ratio, there was a in improvement in survival percentage (99.0 per cent). The highest root length of 62.5 cm was rcorded with T_2 (soil with a pH of 8.1) which was on par with T_8 (soil with a pH of 10.2 + s and + farm yard manure at 2:1:1 ratio), T_7 (soil with a pH of 9.0 + sand + farm yard manure at 2:1:1 ratio) T_9 (soil with a pH of 10.2 + sand + farmyard manure at 2:1:1 ratio) and T_3 (soil with a pH of 9.0). The lowest root length of 47.3 cm was recorded with T_5 (soil with a pH of 10.5). Regarding the shoot length, the highest shoot length of 77.9 cm was recorded with T_6 (soil with a pH of 8.1 + sand + farm yard manure at 2:1:1 ratio) and T_5 (soil with a pH of 10.5) recorded the lowest shoot length of 42.4 cm. The number of leaves was more in T_6, which was on par with T_7. There is not much significant influence on root collar diameter and leaf area due to different treatments tried. The same trend was also noticed in influncing root dry weight except T_4 treatment (soil with a pH of 10.2) where it recorded the lowest root dry weight of 0.48 g., this might be due to higher soil pH may impair the root development of the seedling. T^8 treatment (soil with a pH of 10.2 + sand + frm yard manure at 2:1:1 ratio) recorded the highest shoot dry weight of 3.09 g, where as the lowest shoot dry weight of 1.29 g was recorded with T_5 tratment (soil with a pH of 10.5). Sharma *et al* (1991) had reported in *Eucalyptus terticonis, Eucalyptus camaldulensis* and *Eucalyptus grandis* when grown at pH 9.6 that there was a severe mortality and pH limits corresponding to 50% reduction in survival and growth were 8.70, 8.76, 8.39 and 8.49, respectively. A 50% reduction in growth of seedlings of *Prososipis chilensis, Leucaena leucocephala* var, K28, *Acacia nilotica, Leucacena leucocephala* var k-8 and *Albizia lebbeck* occurred at pH 8.69, 8.77, 9.24, 8.76 and 9.07 respectively, whereas 9.6 pH caused severe mortality of all the species (Sharma *et al* 1992). Seedling growth attributes enhanced by addition of sand and farmyard manure in varying pH might be due to CO_2 liberated by the decaying organic matter and by the plant roots which increases the solubility of calcium carbonate. Consequently the concentration of Ca ions in the soil solution is increased, this ca ions on the soil solution helps to promote the reclamation of alkali soils (Metha, 1983, Daji, 1992).

The results on the effect of soil pH and organic matter on biochemical constituents of 180 days old *Acacia nilotica* seedlings are given in Table3 The highest chlorophyll 'a' content of 4.44 mg g^{-1} was recorded with T_9 treatment (soil with a pH of 10.5 +

sand + farm yard manure at 2:1:1 ratio) where as T_4 (soil with a pH of 10.2 recorded the lowest chlorophyll 'a' content of 2.40 mg g^{-1}. The highest chlorophyll 'b' content of 4.27 mg g^{-1} and total chlorophyll content of 7.46 mg g^{-1} was recorded with T_5 (soil with a pH of 10.5) whereas the lowest value for chlorophyll 'b' (2.49 mg g^{-1}) and total (5.35 mg g^{-1}) chlorophyll were recorded with T^2 (soil with a pH of 8.2).

The total N content of the treatment ranges from 1.47 to 2.91 per cent. T_1 (control) treatment registered the highest total 'N' content of 2.91 per cent followed by T_6 (soil with a pH of 8.1 + sand + farm yard manure at 2:1:1 ratio) with a value of 2.66 per cent. When the pH of soil was increased to 10.5, there was a drastic reduction in total N content (1.47 per cent). This may be due to microorganisms which are involved in the decomposition and transformation of organic N in the system declined in the alkali pH ranges (Patra *et al* 1996). The total P and K content of the plant sample ranges from 0.30 to 0.68 per cent and 1.40 to 2.22 per cent respectively. The highest total P content (0.68 per cent) and the lowest K content (1.40 per cent was recorded with control treatment, whereas the highest total K content of 2.22 per cent was recorded with T_6 treatment (soil with a pH of 8.1 + sand + farm yard manure at 2:1:1 ratio). The lowest K in T^1 treatment might be due to more leaching of K in porus soil (Dutta and Joshi, 1990).

It is concluded that *Acacia nilotica* has a wider range of adaptability in relation to pH. The species is able to tolerate soil pH of 10.5, when the soil is mixed with sand and farmyard manure mixture at 2:1:1 ratio, expressing higher values for germination, seedling and biochemical attributes.

Table 1. Effect of soil pH and organic matter on germination and initial seedling vigour of *Acacia nilotica*

Treatments	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (mg seedling^{-1})	Vigour Index
T_1	90.0^{ab} (86.59)	10.6^{abc}	10.3^{bcd}	8.6^{ab}	2064^{b}
T_2	99.0^{ab}(85.25)	10.9^{ab}	11.1^{abc}	10.1^{a}	2174^{ab}
T_3	100.0a(88.19)	11.2^{a}	12.1^{a}	8.2^{abc}	2325^{a}
T_4	97.3^{abc}(82.31)	10.0^{bcd}	10.4^{bcd}	6.5^{cd}	1988^{bc}
T_5	91.5^{c}(73.03)	8.9^{c}	9.4^{d}	6.1^{d}	1677^{d}
T_6	97.2^{abc}(82.47)	10.0^{bcd}	10.7^{bcd}	8.5^{abc}	2014^{ab}
T_7	98.4^{ab}(85.83)	10.0^{bcd}	12.2^{a}	9.8^{a}	2186^{ab}
T_8	98.0^{ab}(83.28)	9.8^{cde}	11.3^{ab}	9.2^{ab}	2062^{b}
T_9	95.0^{bc}(76.62)	9.6^{de}	9.7^{cd}	7.2^{bcd}	1826^{cd}

Figures in parentheses indicate arc sine values)
Means followed by same letter in a column are not significantly different by DMRT

Table 2. Effect of soil pH and organic matter on seedling attributes of 180 days old *Acacia nilotica*

Treatments	Surival (%)	Root length (cm)	Shoot length (cm)	Number of leaves / seedling	Root collar diameter (cm)	Root dry weight (g)	Shoot dry weight(g)	Leaf are (cm^2)
T_1	99.4^{ab}(86.34)	57.3^{b}	66.4^{cd}	2218^{b}	0.33^{a}	0.8^{a}	1.76^{bc}	0.083^{a}
T_2	98.0^{a}(89.01)	62.5^{a}	71.7^{b}	2833^{ab}	0.33^{a}	0.84^{a}	2.66^{ab}	0.055^{a}
T_3	98.0^{ab}(82.79)	58.6^{ab}	71.2^{b}	2156^{b}	0.30^{a}	0.72^{ab}	2.52^{abc}	0.069^{a}
T_4	96.4^{bc}(79.49)	48.0^{c}	67.4^{cd}	2887^{ab}	0.27^{a}	0.48^{b}	2.09^{abc}	0.066^{a}
T_5	96.4^{c}(74.13)	47.3^{c}	42.4^{f}	2513^{ab}	0.23^{a}	0.68a^{b}	1.29^{c}	0.060^{a}
T_6	99.0^{ab}(84.62)	55.8^{b}	77.9^{a}	3437^{a}	0.37^{a}	0.95^{a}	2.58^{ab}	0.064^{a}
T_7	98.0^{a}(88.40)	60.0^{ab}	57.8^{c}	3354^{a}	0.33^{a}	0.84^{a}	2.44^{abc}	0.058^{a}
T_8	99.3^{ab}(86.15)	61.6^{a}	65.1^{d}	2493^{ab}	0.30^{a}	0.77^{ab}	3.09^{a}	0.072^{a}
T_9	99.0^{ab}(83.46)	58.4^{ab}	68.1^{c}	2683^{ab}	0.23^{a}	0.73^{ab}	2.00^{abc}	0.059^{a}

Figures in parentheses indicate arc sine values)
Means followed by same letter in a column are not significantly different by DMRT

Table 3. Effect of soil pH and organic matter on biochemical constituents of 180 days old *Acacia milotica* seedling

Treatments	Chlorophyll content (mg/g)			Total nitrogen content (%)	Total phosphorus content (%)	Total potassium content (%)
	a	b	Total			
T_1	2.57^{cd}	2.57^{d}	5.36^{d}	2.91^{a}	0.68^{a}	1.40^{f}
T_2	2.38^{d}	2.49^{d}	5.35^{d}	2.31^{c}	0.44^{d}	1.63^{e}
T_3	2.79^{c}	3.53^{b}	6.44^{b}	1.64^{e}	0.30^{f}	2.08^{b}
T_4	2.40^{d}	3.16^{c}	6.42^{b}	1.47^{f}	0.63^{b}	1.82^{c}
T_5	3.47^{b}	4.27^{a}	7.46^{a}	1.15^{g}	0.45^{d}	1.76^{cd}
T_6	2.55^{cd}	3.43^{bc}	7.46^{a}	2.66^{b}	0.37^{e}	2.22^{a}
T_7	2.75^{c}	3.27^{bc}	5.81^{c}	1.82^{d}	0.45^{d}	1.63^{e}
T_8	3.36^{b}	3.38^{bc}	6.53^{b}	1.65^{e}	0.53^{c}	1.67^{de}
T_9	4.44^{a}	3.19^{c}	7.55^{a}	1.49^{f}	0.37^{e}	1.65^{de}

Means followed by same letter in a column are not significantly different by DMRT.

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(Received : March 2001 ; Revised : July 2001)