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Influence of Planting Techniques and Amendments on the Performance of Neem (*Azadirachta Indica*) and Changes in Soil Properties in Rainfed Alkali Soil

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Abstract: A field experiment was conducted at Agricultural College and Research Institute Farm, Trichy in an alkali soil (EC 0.18 dSm^{-1}, pH 8.65 and ESP 25.6) receiving an average annual rainfall of 754 mm. Neem (*Azadirachta indica)* seedlings were planted during 1999. Three planting techniques viz., pit system (0.6 x 0.6 x 0.6 m), pit with auger hole (0.30 m dia, 0. 60 m deep) and pit with auger hole (0.30 m dia, 1.20 m deep) were fitted in the main plot and three amendments viz., gypsum @ 50 % gypsum requirement (GR), distillery spent wash @ 150 ml kg^{-1} of soil, gypsum at 25% GR + 50% DSW 75 ml kg^{-1} of soil were assigned to sub plots. The experiment was conducted in a split plot design and replicated four times. The results revealed that pit with augur hole for 120 cm deep among the planting methods and combined application of gypsum @ 25 % GR and DSW @ 75 ml Kg^{-1} of excavated soil recorded better growth in terms of survival per cent, tree height, GSH and GBH by reducing soil pH and ESP and creating favourable soil environments. In pit method, reduction in pH and ESP was observed in the surface 0-30 cm layer, whereas in pit with augur hole method, reduction in pH and ESP was recorded upto 90 cm depth. In rainfed alkali soils, neem trees planted in pit with augur hole for a depth of 120 cm amended with combined application of gypsum at 25% GR + 50% DSW 75 ml kg^{-1} of soil resulted in spot reclamation and increased the growth and performance of neem trees.

Key words: *Alkali soil, augur hole, gypsum, spent wash, reclamation, neem tree growth.*

INTRODUCTION

In India, about 8.6 m ha of land area is affected with the menace of salinity, alkalinity and water logging. Soils in about 2.5 m ha are characterized by high exchangeable sodium, low soluble calcium, high pH and an impermeable calcic horizon around one metre depth [1]. In order to rehabilitate the salt affected lands, specialized, location specific and problem oriented planting techniques and tree species are required. Choice of proper tree species depends upon the local agro-climate, purpose of planting, tolerance to salinity / alkalinity and drought stress[7].

The tree growth in alkali soils is constrained due to inability of their roots to proliferate through the hard canker (calcite pan existing usually at depths below 50-75 cm from the surface). Earlier technique of pit planting suffers from the disadvantage of high requirements of amendments, laborious and non-perforation of roots through calcic horizon. Addition of gypsum @ 50 GR and FYM was recommended upto replacement of original alkali soil[8]. Yadav[9] reported that trees could be established in sodic soils through planting in augur hole filled with amended soil. The detailed nature and properties of soil, treatment responses in terms of tree growth and biomass accumulation have been reported by Hebbara *et al*[3]. However, experiments at Agricultural College and Research Institute, Trichy revealed that application of distillery spent wash (DSW) @ 150 ml kg^{-1} of soil is optimum for the reclamation of calcareous sodic soils for crop production. With this point in view, an experiment was conducted to evolve suitable planting techniques and amendments for neem (*Azadirachta indica)* trees in rainfed alkali soil.

MATERIALS AND METHODS

A field experiment was conducted at Agricultural College and Research Institute Farm, Trichy in an alkali soil (EC 0.18 dSm^{-1}, pH 8.65 and ESP 25.6) receiving an average annual rainfall of 754 mm. Neem (*Azadirachta indica)* seedlings were planted during 1999. Three planting techniques viz., pit system (0.6 x 0.6 x 0.6 m), pit with auger hole (0.30 m dia, 0. 60 m deep) and pit with auger hole (0.30 m dia, 1.20 m deep) were fitted in the main plot and three amendments viz., gypsum @ 50 % gypsum requirement (GR), distillery spent wash @ 150 ml kg^{-1} of soil, gypsum at 25 % GR + 50% DSW 75 ml kg^{-1} of soil were assigned to sub plots. The experiment was conducted in a split plot design and replicated four times. Observations such as survival per cent at 12 months after planting, height of seedlings at 12, 24, 36 and 48 months after planting, girth at base of the trees at 12, 24, 36 and 48 months were recorded. Soil

Table 1: pH, EC and ESP of initial soil profile

Depth	pH	EC (dSm^{-1})	ESP
0-15 cm	8.7	0.18	25.6
15-30 cm	8.9	0.25	25.6
30-60 cm	9.3	0.49	29.2
60-90 cm	9.3	0.40	30.1

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samples were collected at the time of planting and at 36 months after planting at three depths viz, 0-15, 15-30, 30-60 and 60-90 cm and analyzed for pH, EC and ESP using standard procedures.

The analytical results of initial soil profile for pH, EC and ESP are given in Table 1.

RESULTS AND DISCUSSIONS

Survival per cent: Results on effect of amendments and planting techniques on survival per cent of neem seedlings at 12 months after planting is given in Table 2. All the treatments recorded more than 85 % survival. Eventhough, the treatments did not show significant difference, planting neem in pit with augur hole at a depth of 120 cm along with application of gypsum at 25 % GR and DSW at 75 ml Kg^{-1} of soil recorded higher survival percent.Higher survival of more than 85 % indicates the suitability of neem in alkali soil with a pH of 8.5-9.0 under rainfed conditions. Gupta *et al*[2] also reported similar results in alkali soil under rainfed conditions.

Growth parameters: Planting techniques did not show much difference in height of neem seedlings at initial growth stages of 12 and 24 months after planting (Table 3 & 4). Even then, neem seedlings planted in pits with augur hole recorded taller plants as compared to pit alone. The increment in growth was more significant at 36 and 42 months after planting. At both these stages, taller trees of height 3.50 and 4.75 m, respectively was recorded in pit with augur hole for a depth of 120 cm. This was significantly superior over the other treatments.

Among the amendments, combined application of gypsum @ 25 % GR and DSW @ 75 ml Kg^{-1} of dug up soil was found to be significantly superior over the application of gypsum and DSW alone in increasing the plant height of neem. The combined application might have resulted in higher calcium addition besides reducing the pH because of the acidic nature of the DSW. At three and four years after planting, taller trees of neem (3.66 and 5.03 m) were observed when planted in pit with augur hole for a depth of 1.2 m filled with gypsum and DSW.

The effect of planting techniques and amendments on girth of neem trees showed similar trend as that of plant height (Table 5 & 6). Among the planting techniques, pit with auger hole for 120 cm recorded higher GSH and GBH of 28.92 and 21.74 cm, respectively and among the amendments, application of gypsum @ 25% GR and

Table 2: Effect of planting technique and amendments on survival % of neem at 12 months after planting.

Treatments	Gypsum	DSW	Gypsum +DSW	Mean
Pit system	85.42	82.29	92.71	86.80
Pit with auger hole (60cm)	87.50	89.58	92.71	89.90
Pit with auger hole (120cm)	91.67	88.54	92.71	90.90
Mean	88.19	86.60	92.71	

Statistical analysis not done

Table 3: Effect of planting techniques and amendments on the height of trees (cm).

	Gypsum	DSW	Gypsum +DSW	Mean	Gypsum	DSW	Gypsum +DSW	Mean
Treatments	12 months				24 months			
Pit system	123.5	137.8	142.9	134.7	199.4	222.8	206.8	209.7
Pit with auger hole (60cm)	148.9	157.2	169.9	158.7	209.7	221.8	236.6	222.7
Pit with auger hole (120cm)	151.3	159.5	162.4	157.7	194.3	213.1	226.6	211.3
Mean	141.3	151.5	158.4		201.1	219.3	223.3	
	M	S	M at S	S at M	S	M	M at S	S at M
SEd	3.8	3.5	6.9	5.9	3.2	7.3	7.87	6.93
CD	9.4	8.6	16.2	13.8	7.8	17.8	19.2	16.9

Table 4: Effect of planting techniques and amendments on the height of trees (cm).

	Gypsum	DSW	Gypsum +DSW	Mean	Gypsum	DSW	Gypsum +DSW	Mean
Treatments	36 months				48 months			
Pit system	264.5	205.5	269.8	246.6	303.8	315.8	359.6	326.4
Pit with auger hole (60cm)	265.5	307.0	331.8	301.4	378.3	396.3	407.5	394.0
Pit with auger hole (120cm)	329.5	355.3	365.5	350.1	451.0	473.9	502.9	475.0
Mean	286.5	289.3	322.3		377.7	395.3	423.3	
	M	S	M at S	S at M	M	S	M at S	S at M
SEd	22.30	7.70	24.8	13.32	11.65	6.03	14.44	10.44
CD	54.4	18.8	60.4	32.5	28.33	12.67	33.60	21.94

Table 5: Effect of planting techniques & amendments on girth at stump height of trees (cm).

	Gypsum	DSW	Gypsum +DSW	Mean	Gypsum	DSW	Gypsum +DSW	Mean
Treatments	36 months				48 months			
Pit system	12.49	12.52	12.98	12.66	16.52	19.01	20.94	18.82
Pit with auger hole (60cm)	12.46	12.41	14.66	13.18	22.82	23.68	24.46	23.65
Pit with auger hole (120cm)	12.72	14.06	15.68	14.15	26.89	28.84	31.04	28.92
Mean	12.55	12.99	14.44		22.08	23.84	25.48	
	M	S	M at S	S at M	M	S	M at S	S at M
SEd	0.70	0.53	0.41	0.31	0.93	0.27	1.01	0.48
CD	1.69	1.30	2.49	2.26	2.28	0.58	2.42	1.01

Table 6: Effect of planting techniques and amendments on girth at breast height of trees (cm).

	Gypsum	DSW	Gypsum +DSW	Mean	Gypsum	DSW	Gypsum +DSW	Mean
Treatments	36 months				48 months			
Pit system	9.43	9.74	10.67	9.95	12.37	14.55	15.45	14.12
Pit with auger hole (60cm)	9.71	9.89	12.14	10.58	16.09	17.73	19.01	17.61
Pit with auger hole (120cm)	9.82	10.31	12.03	10.72	20.82	21.49	22.91	21.74
Mean	9.65	9.98	11.61		16.43	17.92	19.12	
	M	S	M at S	S at M	M	S	M at S	S at M
SEd	0.28	0.23	0.44	0.42	0.89	0.30	0.99	0.53
CD	0.69	0.59	1.08	1.02	2.17	0.64	2.35	1.11

Table 7: Effect of planting technique and amendments on soil (profile) pH, EC and ESP at 36 months after planting of neem.

		pH				EC (dSm-1)				ESP			
Treatments	Depth	S1	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
Pit system	0-15	7.82	8.23	8.15	8.07	0.28	0.17	0.23	0.23	16.93	21.03	19.16	19.04
	15-30	8.13	8.32	8.18	8.21	0.32	0.24	0.34	0.30	19.32	21.78	20.32	20.47
	30-60	9.02	8.96	9.01	9.00	0.35	0.33	0.52	0.40	29.73	27.29	29.64	28.89
	60-90	9.46	9.11	9.34	9.30	1.32	1.96	1.92	1.73	34.13	30.68	32.76	32.52
Pit with auger hole (60cm)	0-15	7.97	8.37	8.07	8.14	0.16	0.28	0.13	0.19	17.11	21.67	17.73	18.84
	15-30	8.25	8.45	8.12	8.27	0.17	0.32	0.17	0.22	21.16	22.53	19.21	20.97
	30-60	8.23	8.79	8.19	8.40	0.3	0.5	0.37	0.39	21.32	24.76	19.68	21.92
	60-90	9.01	8.81	8.76	8.86	0.94	1.9	1.24	1.36	28.42	26.15	23.36	25.98
Pit with auger hole (120cm)	0-15	8.04	8.48	8.33	8.28	0.22	0.32	0.23	0.26	17.98	21.99	20.59	20.19
	15-30	8.18	8.63	8.45	8.42	0.29	0.45	0.33	0.36	18.86	23.07	21.37	21.10
	30-60	8.52	8.77	8.76	8.68	0.38	1.43	0.96	0.92	22.47	24.77	23.98	23.74
	60-90	8.89	8.96	8.91	8.92	1.11	2.13	2.13	1.79	26.35	27.23	28.63	27.40

Statistical analysis not done

DSW 75 ml kg^{-1} of soil resulted in increased girth of 25.48 and 19.12 cm, respectively at stump height and breast height.

Similar trend of results was observed with regard to girth at stump height (GSH) of neem trees at 36 and 48 months. This might be due to the better root growth due to the amendments which could have improved the uptake of water and nutrients resulting in better growth. Similar results of higher root growth, plant height resulting in higher GSH and GBH in alkali soil were reported earlier [5, 6].

Soil properties: In the pit method of planting, influence of soil amendments were restricted to only surface layer of 0-30 cm. The application of gypsum, DSW and combination of gypsum and DSW reduced the pH to 7.82, 8.23 and 8.15, respectively from an initial value of 8.8. In case of pit with augur hole method, reduction in pH values were also observed in deeper layers of 30-60 and 60-90 cm. This favourable environment of reduced pH might have resulted in higher tree growth of neem expressed in terms of height, GSH and GBH. The EC did not show significant difference and the values were below the critical limit since these soils are nonsaline in nature. However, increase in EC was observed in DSW treatments. Profile analysis indicated an increased EC level in deeper layers of 60-90 cm which might be due to the presence of leached sodium salts replaced by calcium applied through amendments.

In case of ESP, similar trend as that of pH was observed. Application of amendments reduced the ESP to 19.0 and 20.2 as compared to the initial value of 25.6 in the surface of 0-15 cm. In case of pit with augur hole method, lowering of ESP was observed in subsurface soil layers like that of pH due to the influence of treatments. Reduction in ESP due to the application of DSW in the surface 15 cm of the soil was reported by Gupta *et al*., [2]. Increased solubility and efficiency of gypsum when applied in conjunction with acid forming material was reported by Redly *et al*[4].

Conclusion: The results revealed that pit with augur hole for 120 cm among the planting methods and combined application of gypsum @ 25 % GR and DSW @ 75 ml Kg^{-1} of excavated soil recorded better growth in terms of survival per cent, tree height, GSH and GBH. In pit method, reduction in pH and ESP was observed in the surface 0-30 cm layer only whereas in pit with augur hole method, reduction in pH and ESP was recorded upto 90 cm depth. In rainfed alkali soils, neem trees planted in pit with augur hole for a depth of 120 cm amended with combined application of gypsum at 25% GR + 50% DSW 75 ml kg^{-1} of soil resulted in spot reclamation and increased growth.

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