"A DECADE OF RESULTS FROM TWO TREE TRIAL PLANTINGS ON SALT AFFECTED AGRICULTURAL LAND"

RES. W/P 7/67

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INTRODUCTION

The copies of reports which follow in this booklet relate to investigations carried out under a Departmental research Working Plan 7/67 started in 1967.

The objectives were to test the salt tolerance of the species listed in the reports in the Wheatbelt area of West Australia and the techniques for establishing seedlings in such areas.

The location of the trials is at Wongan Hills Agricultural Research Station (lat. 30' 45' long. 116° 15') and receiving about 350mm of rain per annum during a mediterranean style climate of winter rains and long dry summer.

The locality selected was originally a creek bed in a cleared paddock, previously cleared for 40-50 years and subjected to substantially wheatgrowing and sheep grazing on a varying rotational basis of about 3 years lea pasture and one (1) year wheat or oat cropping.

The expression of salt ensued as a surface "scald" along the creek bed, upstream from a similar but more severe salt outbreak distant about 300-400m and planted in 1948-50. Pasture grasses were replaced by barley grasses before these too, were removed by excessive salt concentrations of mainly sodium and potassium, leaving bare soil encrusted with precipitated salts.

The soils are essentially shallow loamy sands 12"-18" over loamy clay gravels down to 5-6' at least, generally impervious in dry periods. The creek area has gently sloping topography. In part, the poor angle of slope possibly leads to poor drainage rates, with consequent build up of salts in sites and eventual rise to the surface.

It was considered tree growth, if it could survive salt effects, would lower water table levels to that where surface expression would not occur and drainage would continue in the subsoil layers.

As the latter report indicates, there appears to be a complex pedological ecological process involved in the soil profile which allows through flow of soil moisture (plus salts) not only laterally, but apparently vertically, with consequent removal and or storage of salts by flocculation of clays at various points in the profile. The means by which organic residues from the species planted assist this process is unknown, but evidently holds the key(s) to the suitability and tolerance to salt of various species and their ecological position in the control of salt movement and storage.

Photocopy of photographs included, indicates the success in re-establishing tree growth to date, over a period of 10 years.

Reference to the Avondale site is no longer relevant, since this site has been abandoned for the experiment due to lack of homogeneity of the site.

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RESULTS OF FURTHER REMEASUREMENTS IN SALT LAND TREE PLOTS - WONGAN HILLS AGRICULTURAL RESEARCH STATION

NOVEMBER 1977 W/P 7/67

SUMMARY

(1) Soil samples taken at previously located positions have been analysed for T.S.S. %, Na Cl %, pH & Carbon %, by Como Research staff and indicate apparent encouraging change in pH, Carbon % & T.S.S. %/Na Cl % at various levels in the profile.

(2) Climatic influences mainly winter rainfall appear to exsert a marked effect on levels of T.S.S. & Na Cl % and consequently influence soil pH.

(3) Tree growth effects on soil structure, chemistry & carbon % are inferred from the changing levels of T.S.S. & Na Cl at the same levels in the profile since planting.

There appears little effect up to age 5 years of tree growth in any species for spacings adopted, in this type of situation.

(4) Penetrability of the profile on the south side of the plot is considered to have improved; this is regarded as being due to moisture retention in part and also possibly to increased carbon levels, derived from organic matter complexes.

(5) A difference appears to be emerging between soil properties, mainly T.S.S. and pH between River Gum areas and Swamp Mallet, Salt River Gum plantings.

This is attributed to crown density and tannin factors and suggests that heavy surface artificial mulching with materials high in tannin materials (e.g. sawdust, pine bark etc.) could improve soil conditions more rapidly.

(6) Overall, there appears to be less evidence of surface salt accumulation. Recolonizing by Barley grass is fairly widespread, but suppressed beneath trees.

(7) Remeasurements were made of trees planted. Little height growth is evident over the last 2½ years.

1. INTRODUCTION

These remeasurements further augment data obtained to date as per previous reports of July 1975, April 1969 and April and November of 1968 and November 1967.

The measurements made were those of tree development of all species planted except Tamarix sp., to check progress.

Soil samples were also taken from previously located positions across the treatment area to check changes if any, which are occurring in various levels of the profile.

Photographic records were also taken of the plot which illustrate progress to date, of tree growth.

C.S.I.R.O. Land Research advise that this tree plot occupies 1.3% of the total catchment area in which the trees have been planted.

2. TREE REMEASUREMENTS

All trees planted were occularly remeasured as to height, crown width, thrift and crown density.

The results of these measurements are summarized in Table 1, together with survivors.

These indicate a marked decrease in tempo of growth of any parameter, as C.A.I. figures show.

3. SOIL SAMPLES

Samples at each of 3 sampling positions were again collected for analysis by Mr. Hatch's staff at Como.

These analyses are set out in Table 2 for comparative purposes and include an estimate of carbon % in the sample.

This was included in an effort to deduce what level of penetration in the profile, organic material is attaining.

The contrast between recovery levels of carbon under tree canopy and no tree canopy is marked. (See histogram 1).

Graphs 1 and 2 have been prepared to indicate changes with time of T.S.S. % & Na Cl % at various levels in the profile at each of the sampling positions as well as pH changes at various levels (Graph 2).

4. GENERAL IMPRESSIONS

Recolonizing grasses appear to be increasing in concentration, principally Barley Grass (Hordium murinum) in open areas.

Under tree canopy, this species has been almost suppressed e.g. Swamp Mallets. Under River Gums, the lesser crown density has not caused suppression of Barley grass to anywhere near the same extent.

As indicated by the C.A.I. of height growth, growth has become rather static in trees planted and suggests that under current conditions of the past 2½ years, ground moisture and or soil penetrability have denied trees access to essential moisture and nutrients for further growth. A drought of probably 2 years duration is currently being experienced, which is regarded as being the main cause of lack of growth.

5. DISCUSSION

5.1 T.S.S. & Na Cl % Changes

As shown in Graph 1 the analysis from centre of the plot (the drainage channel and area of initially maximum saltation) indicate a continuing decline in T.S.S. % & Na Cl % since around 1973.

This event is evidently suggestive of the fact that the greater proportion of salt accumulation has been derived by lateral movement from uphill slopes to the creek. The further suggestion of this data is that the planting of trees along the creek has tended to prevent salt issuing immediately into the creek bed area.

This contention would be supported by the fact that T.S.S. & Na Cl % is again increasing in tree planted areas on the South side of the plot and tending to stabilize on the Northern side.

Whether the canopy type of the trees in each of these positions has an influence on the rate at which salt movement occurs laterally to the creek is unknown. Certainly the crown density of Swamp Mallet and Salt River Gum is far greater and hence one could reasonably assume root density to be greater (data from May 1975 support this also) in which case, it could be reasonable to expect greater impedance in the area of Euc.spathulata and Euc.sargenti plantings although slope of terrain could be a factor also.

5.2 pH of Soil Profile

Graph 2 indicates changes in pH over the period of 10 years of investigation. These show that pH of the surface layers are now lower than sub soil layers in the River Gum area and have been so declining for about the past 5 years.

The central (creek) area appears to have remained static, changes evidently following out reactions to seasonal climatic effects of wet and dry winter rainfall, these alternately flushing away and retaining salts in the soil surface levels at least to 12" depth.

Consequently, there would appear to be little hope of improving the soil condition in this zone unless:-

(i) an improved (deepening) drainage channel were installed to allow surplus water to gravitate to a local lake or sump.

(ii) salt tolerant shrubs such as Melaleucas and Casuarinas are planted in close proximity to the water course to stabilize the seasonal fluctuations of T.S.S. & Na Cl levels.

The Southern area under Swamp Mallets etc. indicate a currently increasing T.S.S. & Na Cl levels after an earlier fall. This is suggestive that perhaps these are the wrong species to plant in this situation by virtue of root density impedance to lateral saltwater movement to the extent that salts are being deposited beneath these stands of trees.

In contrast with the River Gum area, it is noticeable that salt concentrations are increasing at depth in the profile i.e. 12" only (at present anyway). This suggests root density and slope interact favourably to allow passage of salts to the creek at least in the surface layers without undue accumulation.

Soil type however, may also be assisting in maintaining this current balance.

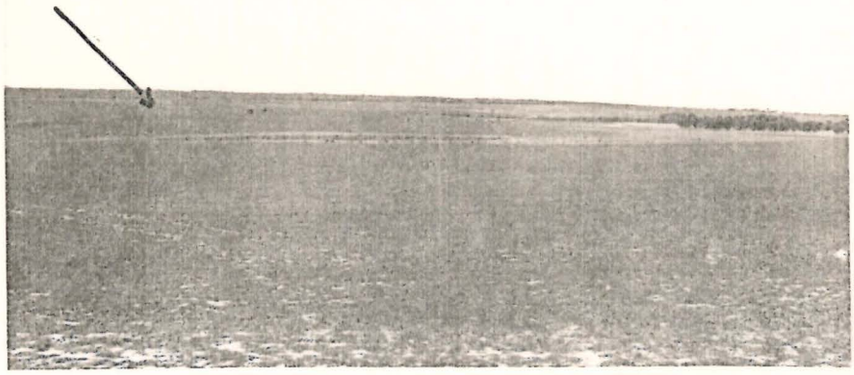
It is still unknown therefore whether high root density is ipso facto, a prerequisite of a salt tolerant species. If it is not, then it is considered the tree species being used on the South side could be unsuitable and Casuarinas, Tamarix etc. could be better suited.

5.3 Organic Carbon %

These initial assays of this element indicate an almost 100% improvement in surface soil C % compared to the creek bed area.

Concentrations of C do not vary markedly from 6 - 24" in the creek bed area and hence it is assumed that what C is there, is probably residual or a stabilized input from adjacent lea paddocks. It also infers little or no vertical penetration is occurring in the profile.

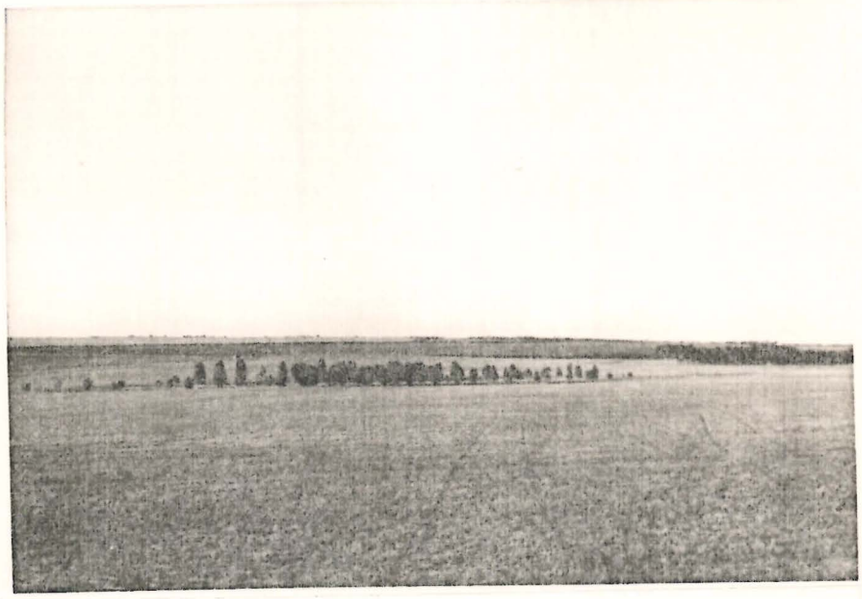
APRIL 1968



View of New Salt plot (arrowed) at Agric. Res. Stn. WONGAN HILLS. 1948-50 plantings at R. Rear.

Approx 5 yrs.

Abt MAY 1973

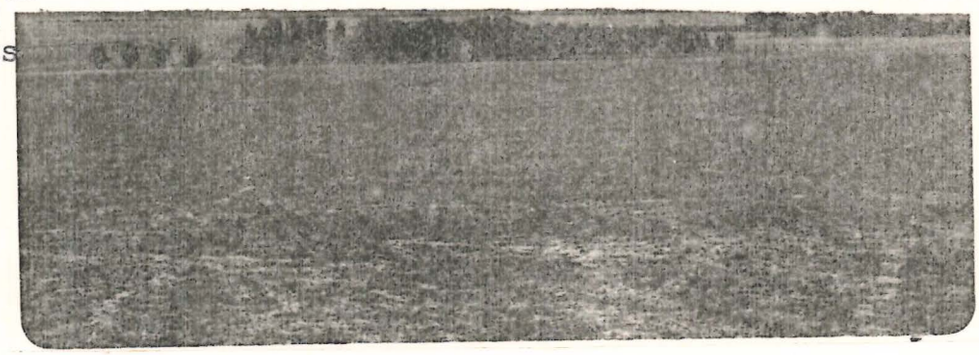


New plot after approx. 5 yrs. since planting.

Approx 5 yrs

NOV. 1977

(i) River Gum at R.H. end of plot
(ii) Salt River Gums & Swamp Mallets on foreground
(iii) Coastal Moorts obscured
(iv) T.aphylla at L.H. end by cuttings by Agric. Staff



Recent view of same plot from same position.

This is evidently not true of the situation under tree growth which show marked C % up to 18" below ground level.

This is to be expected from the litter fall accumulations below tree cover and rooting systems.

There appeared to be a marked improvement in the penetrability of the profile beneath the Swamp Mallets which could be due to better moisture retention solely rather than soil physical condition improvement. However, the penetrability seemed to be unconfined to an impervious clay which is frequently found in heavily podsolized soils, with moisture moving laterally from such hardpan areas and on the upper surface of it.

This lends support to the writer's contention that the vertical movement of C in the profile is responsible for improvement in penetrability of the profile, with side benefits of better root penetration and inducement of excess salt ions to move both laterally and vertically to the drainage system. The way in which this action occurs is hypothesized as being the ability of tannin compounds and other organic carbon complexes to maintain soil clay colloids for longer periods in a state of deflocculation.

Whether additions of high tannin materials e.g. Sawdust, pine bark etc., as a surface mulch could improve rapidity of soil improvement is unknown. Mr. C. Malcolm of Dept. Agric. expressed interest in this prospect in 1972 (pers.comm) rather than using chaff.

6. CONCLUSIONS

1. Favourable changes in T.S.S. & Na Cl % have been determined on soil profiles since trees have been planted. These changes appear to be decreasing possibly due to root density/rate of salt water flow interactions.

2. pH of the soil profile has changed since the start of planting with generally lower pH at depths of 12" below ground level.

3. Seasonal fluctuations of pH levels are again demonstrated in the creek area.

4. Organic carbon inputs to the soil profile have been considerable and have penetrated to at least 18" below the surface.

5. Organic carbon in the creek bed area suggest that the organic C input is static and possibly residual from a previous vegetation cover.

6. It seems possible that the wrong species of trees are being used on the South side of the area, their canopy/root density being too high to allow an adequate root of salt water flow in the profile, laterally.

   Casuarinas and Melaleucas and Tamarix could be better suited to areas of low angle topography or on heavier soils having possibly better canopy through fall of rain characteristics, and more favourable root densities.

7. Tree cover appears to have improved soil physical condition as regards penetrability and moisture retention. What this is due to is not certain, but possibly related to chemical action of organic leachates on soil clay colloids.

8. The use of high tannin content surface mulches e.g. sawdust, early in rehabilitation treatment seems worthy of investigation to assess its usefulness as a soil improver.

9. Little benefit appears to have derived from tree plantings until about age 5 years in terms of manipulating salt accumulation zones, as well as improving soil pH and condition generally.

10. Further sampling of organic C to greater depths in the profile seems warranted along with analysis for T.S.S. and Na Cl & pH.

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REFERENCES:-
1. Clive Malcolm - Dept. of Agric. Perth - Pers. comm.
2. A.J. Hart - previous Departmental reports.
3. A.B. Hatch - Laboratory analysis results 1967 - 1977

TABL

SALT LAND TRIAL PLOT - WONGAN HILLS AGRIC. RES. STATION
SUMMARY OF SPECIES, SURVIVALS & GROWTH AT 7/11/77

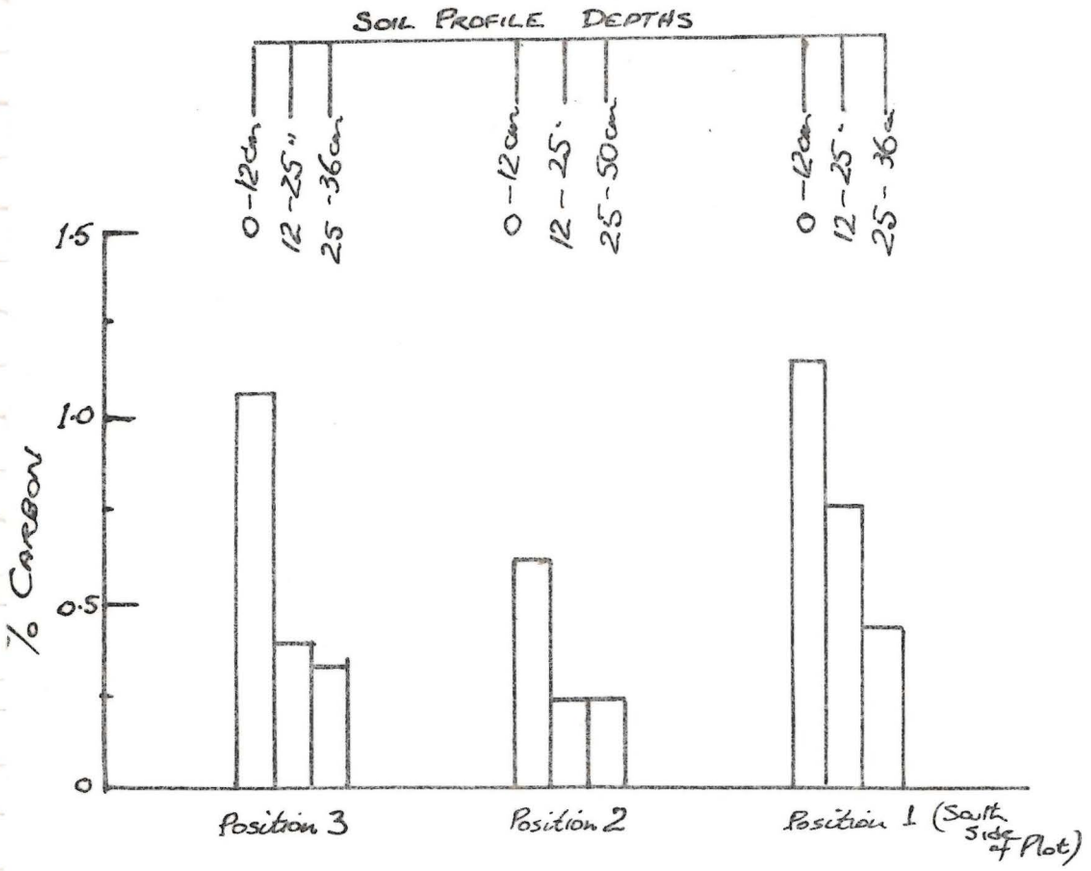
SPECIES	DATE OF PLANTING	No. PLANTED	SURVIVAL COUNTS (Nos) 23/4/68	6/11/68	16/11/71	13/4/73	26/5/75	7/11/77	MEAN PROGRESSIVE HEIGHT (m). 23/4/68	6/11/68	16/11/71	13/4/73	26/5/75	7/11/77	C.A.I. 4/73 (m/annum)	C.A.I. 11/77 (m/annum)	REMARKS
1.Tamarix gallica "Spring Flg. Taxarix"	Approx. 1967	N/Av.	-	-	-	-	-	-		-	-	-	-	-			Cuttings pl Agric. Dept
2.Euc.spathulata "Swamp Mallet"	6/7/67	South 20	7	7	7	7	7	7		1.46	4.06	5.1	6.9	7.43	0.87	0.42	Very good t
		North 5	2	2	1 (1 blown over)	1	1	1		1.51	4.75	6.0	-	12.0	1.04	1.08	Single tree
3.Euc.sargenti "Salt River Gum"	"	South 10	6	7	6	6	6	6		1.12	2.88	4.4	6.4	7.5	0.77	0.56	Good to V.G
		North 14	6	6	6	6	6	6		1.125	5.30	5.9	7.90	8.5	1.03	0.47	thrift on a
4.Euc.camaldulensis "River Gum"	6/7/67	South 23	10	8	10	10	10	10		0.79	2.13	5.58	6.86	6.94	0.97	0.24	Fair to goo
		North 23	20	20	23	23	23	22		0.96	1.84	4.27	7.15	6.19	0.74	0.34	Good to V.G
	4/1968	Bags 12	-	9	3	3	2	3		-	-	-	6.35	5.67	-		Good thrift
5.Euc.platypus var. heterophylla "Coastal Moort"	6/7/67	12	12	7	7	7	7	7		0.96	3.8	4.4	5.2	5.43	0.77	0.18	Very good t
	Oct 1970	6	-	-	4	N/Av	3	3		-	-	-	1.9	2.17	-	-	Fair thrift
6.Euc.visdoni	13/4/73	2	-	-	-	-	-	-									Creek centr all failed 5/75
7.Euc.amplifolia	"	2	-	-	-	-	-	-									
8.Euc.planchoniana	-	-	PLANTED AT AVONDALE ONLY														
9.Euc.cladocalyx nana	-	-	" "						" "								

TAB

WONGAN HILLS AGRICULTURAL RESEARCH STATION - SOIL SAMPLE ANALYSES
SUMMARY FROM SALT LAND TREE PLOT (1967-77)

SAMPLE POSITION	DEPTH IN PROFILE	NOV 1967 ANALYSIS			MAY 1968 ANALYSIS				JUNE 1973 ANALYSIS			MAY 1975 ANALYSIS			NOV 1977 ANALYSIS				CHANGES SINCE 1967 (+ or -)			REMARKS
		PH	TSS%	%NaCl	PH	TSS%	%NaCl	% GRAVEL	PH	TSS%	%NaCl	PH	TSS%	%NaCl	PH	TSS%	%NaCl	%C	PH	TSS%	%NaCl	
1 (SOUTH SIDE)	0-6"	6.13	.188	.138	5.20	.129	.085	11.8							5.55	.470	.460	1.14	-0.58	+.282	+.222	
	6-12	6.43	.132	.101											4.75	.350	.384	0.75	-1.68	+.218	+.283	No Data available
	12-18								N/Available						5.20	.480	.481	0.41				
	15-18																					
	36				7.70	.119	.078	27.3														
	54																					
2 (CENTRE)	0-6"	7.82	1.475	1.654	7.10	.710	.548	3.1	7.55	1.115	.89	6.30	.876	.588	6.85	.098	.105	0.61	- .97	-1.377	-1.549	11/77 - Water Table depth - = 30" 4/68 - no water in Hole - change from 1967-1968 No data availab.
	6-12								8.05	.128	.08	6.70	.263	.220	7.20	.125	.142	.24	-0.85	-.003	+ .062	
	12-18											6.85	.182	.161	7.60	.166	.183	.24	+0.75	-.016	+ .022	
	15-18								8.18	.175	.11											
	36	8.54	.184	.160	8.35	.076	.055	4.0											- .19	-.108	- .105	
	54	8.60	.173	.095																		
3 (NORTH SIDE)	0-6"	6.07	1.172	1.063	5.60	.252	.120	2.2	6.03	.688	.50	5.60	.229	.189	5.20	.126	.145	1.06	0.87	-1.046	-.918	
	6-12								5.83	.186	.12	5.55	.168	.148	4.80	.152	.173	.38	-1.03	- .016	+.025	
	12-18											5.85	.340	.195	5.30	.208	.234	.32	- .55	- .132	+.039	
	15-18																					
	26	6.88	.121	.060								6.10	.465	.368					- .78	+.344	+.308	-Change between
	36				8.30	.126	.070	58.8											+1.43	-.181	-.123	- " "
	42	6.69	.344	.251	8.12	.163	.128	-														
	54																					

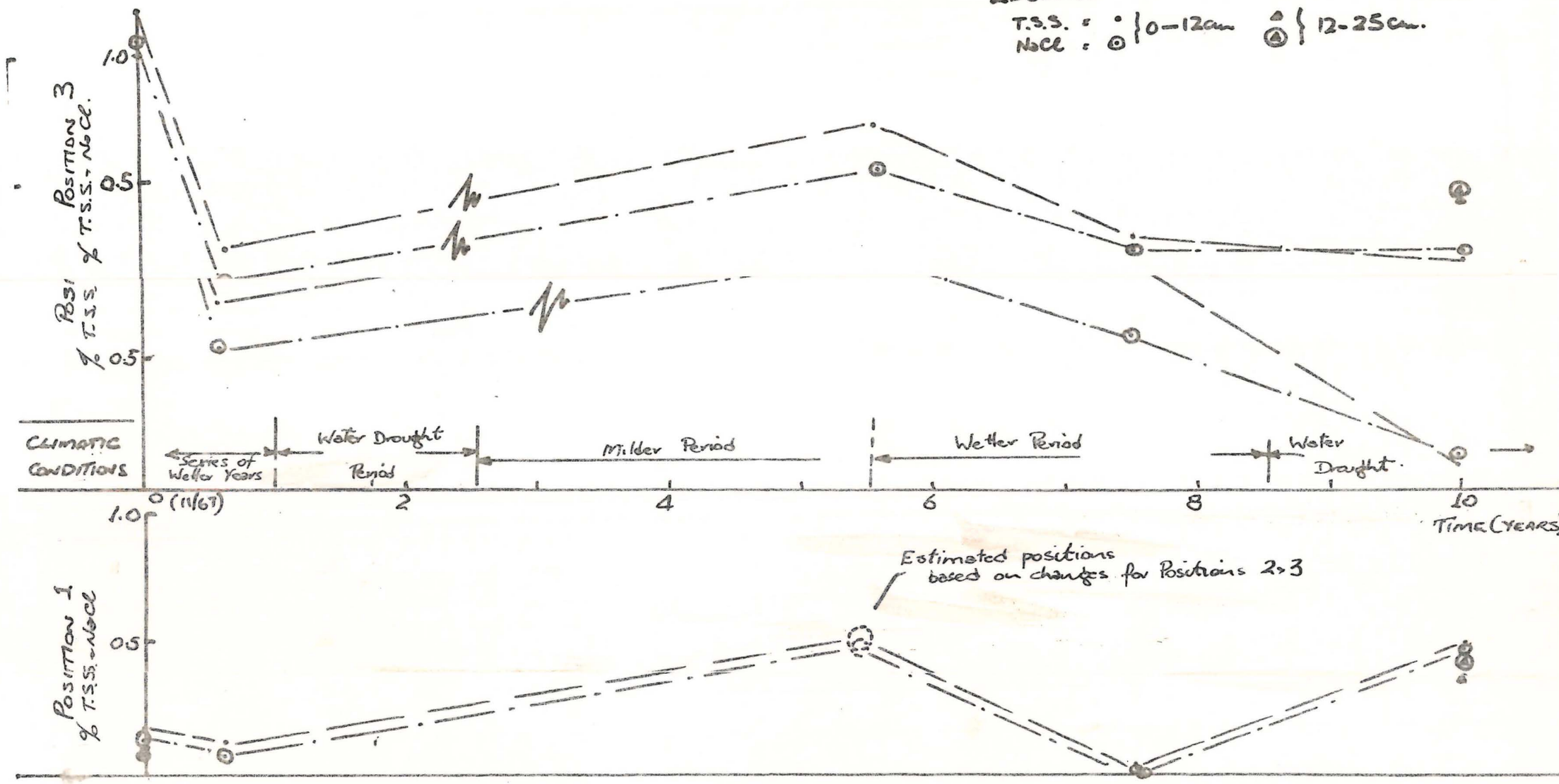
Histogram of Soil Carbon (%) for 3 Sampling Positions in Salt Land Tree Plots – Wongan Hills Agric. St^N Nov. 1977



Soil Type :	Quartz Sand + gravel over gravelly clay	Shallow gravelly sand clay over gravelly clay	Gravelly sand clay over gravelly clay.
Tree Species :	Euc. camaldulensis predominantly.	Small Euc. platypus var. heteophylla	Euc. spathulata Euc. sargenti.

GRAPH. 1

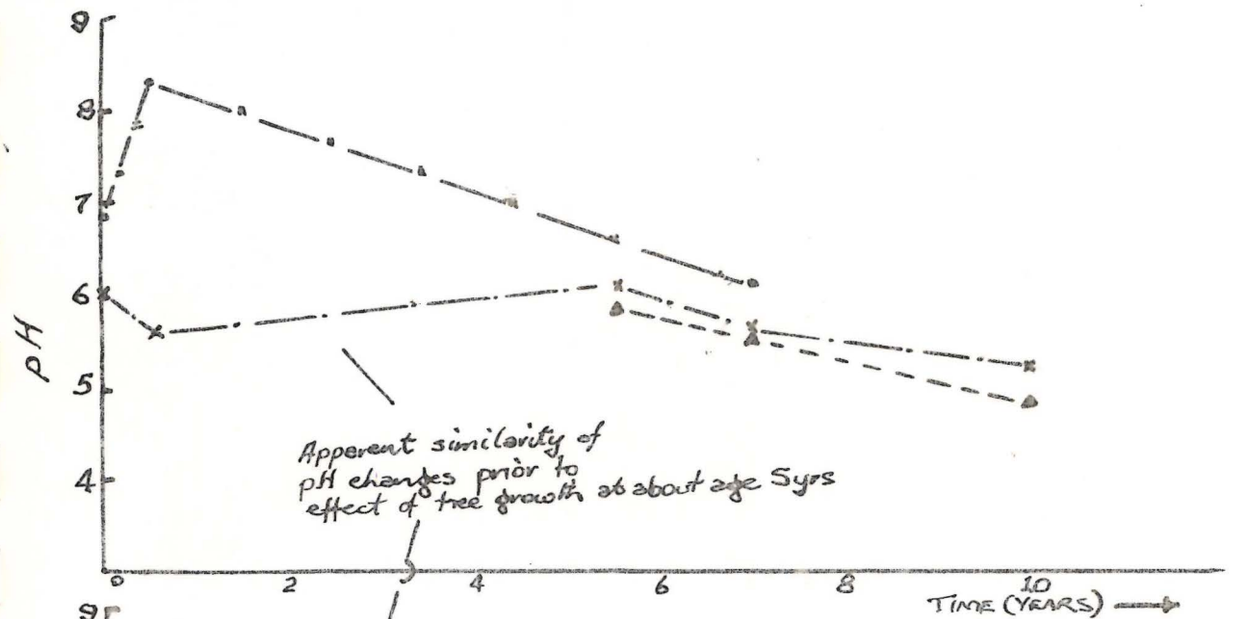
GRAPH of T.S.S. (%), and NaCl (%) at 3 SAMPLING POSITIONS IN SALT LAND TREE PLOT - WONGAN HILLS AGRIC. ST^N 1967-1977

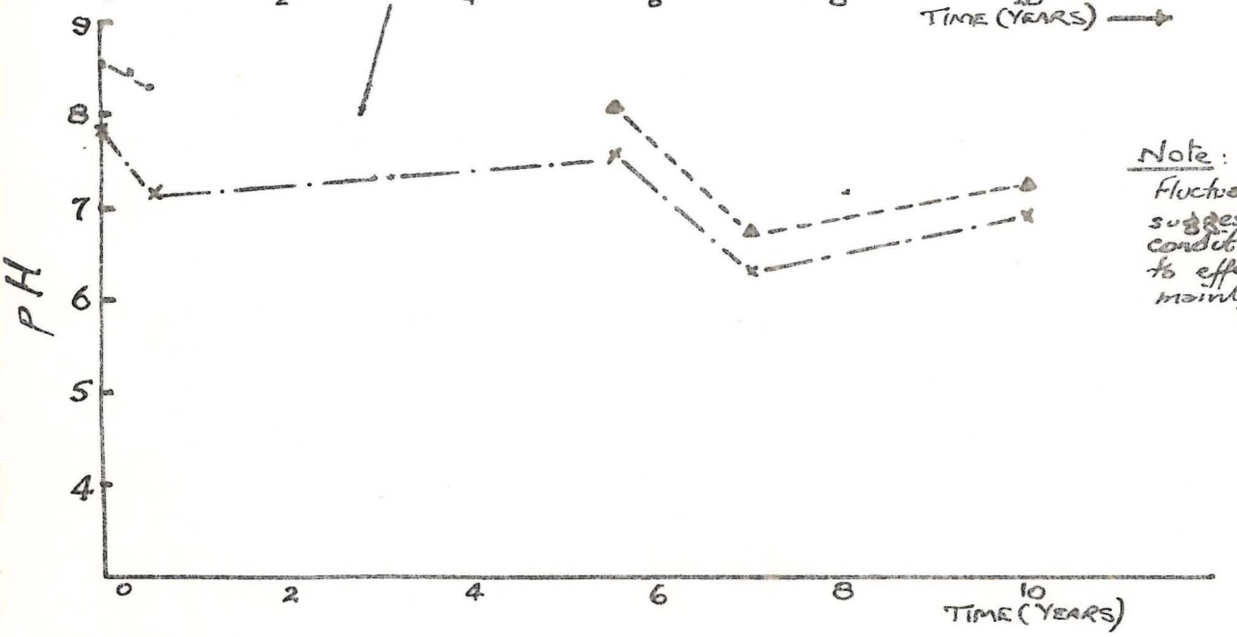


pH Values for 3 Sampling Positions and Different Soil Profile Depths – 1967 - 1977.

Legend

× = 0 – 12 cm
▲ = 12 – 25 cm
○ = 35 – 45 cm
• = 65 – 90 cms.





Note:
Fluctuating values suggestive of unstable condition and subject to effects of climate, mainly rainfall.