Seminar on Best Practices for Urban Tree Management 2010

Understanding Urban Soils for Sustainable Tree Growth: From Theory to Practices

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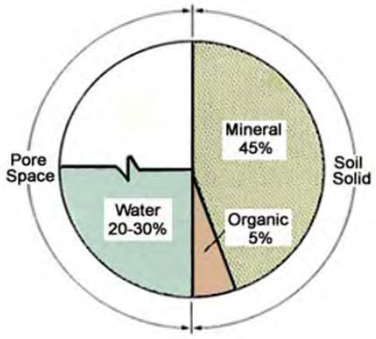
One of the most important factors affecting the growth of urban greenery, including trees, is soil.

An ideal soil is made up of .....



Mineral composition (loam)
- Sand 40%
- Silt 40%
- Clay 240%

The air and water in a soil are extremely variable, and their proportion determines in large degree its suitability for plant growth.

Overseas and local urban/ planter soils

	Overseas studies		Local studies		Present study								
					Central District			Kwun Tong			Wo Che		
	Mall soils[1]	Planter Soils[2]	Urban Soils[3]	Park soils[4]	0-10 cm	10-30 cm	30+ cm	0-10 cm	10-30 cm	30+ cm	0-10 cm	10-30 cm	30+ cm
Texture	Loamy	Clay loam to sandy loam	Sandy	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Sand	49.2	---	83.3	75.4-85.2	70.7	66.5	71.2	72.0	68.3	76.6	73.8	72.6	73.3
Silt	33.3	----	8.2	---	14.3	17.7	16.9	13.3	16.0	11.5	15.7	16.8	15.5
Clay	17.5	----	8.5	4.7-15.8	15.8	15.8	11.9	14.7	15.7	11.9	10.5	10.6	11.2
PH	6.39	8.50	6.04	ND	5.61	6.45	7.07	6.40	7.09	7.96	6.32	6.71	7.01
SOM (%)	1.97	ND	5.00	3.17-4.65	3.45	1.58	0.61	3.91	2.10	1.84	3.05	0.97	0.78
Total N (%)	ND	ND	0.18	0.23-0.60	0.12	0.06	0.02	0.11	0.07	0.07	0.13	0.04	0.02
PO_4 ($\mu g\ g^{-1}$)	50.20	18.00	42.90	0.00-0.02	105.71	77.03	34.94	36.60	30.40	34.80	131.78	47.60	39.35
K (cmol kg^{-1})	0.47	0.63	12.28	ND	0.25	0.22	0.24	0.27	0.21	0.18	0.31	0.18	0.19
NA (cmol kg^{-1})	0.23	2.67	ND	ND	0.18	0.11	0.11	0.12	0.06	0.07	0.08	0.04	0.02
Ca (cmol kg^{-1})	7.80	14.60	ND	ND	5.96	8.82	8.58	8.26	8.99	15.44	6.18	6.55	14.70
Mg (cmol kg^{-1})	1.20	1.35	ND	ND	0.51	0.41	0.35	0.57	0.36	0.39	0.55	0.29	0.24

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(1) Upper 20 cm The Mall soils in Washington, D. C. (Short et al. 1986).
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Source: Chan, W. Y. (1997). A study of Planter Greenery and Planter Soils in Hong Kong, Unpublished M. Phil Thesis, Department of Geography, CUHK, p.81.

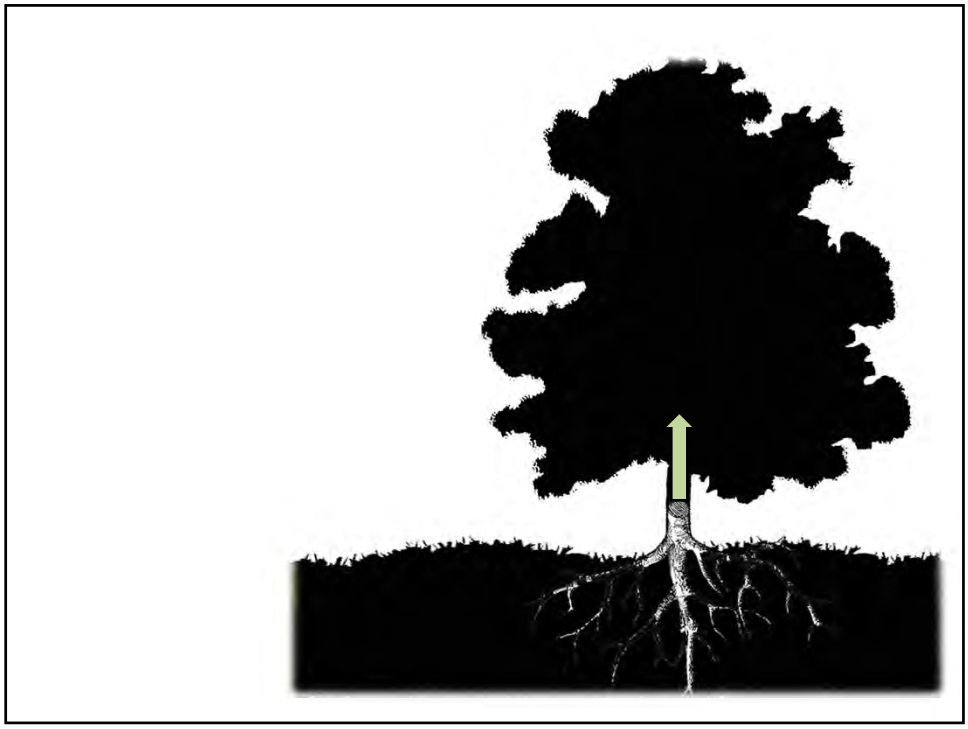
Soil diversity: DG vs. FAS (n=5)

Parameters	DG	FAS	t-test	Rating			Critical level
				High	Medium	Low	
pH	4.68 (0.07)	4.33 (0.07)	***	>7.0	5.5-7.0	<5.5	6.0-7.0
Conductivity (mS cm^{-1})	0.15 (0.003)	1.15 (0.01)	***	----	----	----	----
Clay (%)	18.3 (1.17)	25.7 (2.04)	***	----	----	----	----
Silt (%)	23.9 (1.93)	25.4 (2.24)	NS	----	----	----	----
Sand (%)	57.8 (0.90)	48.9 (1.66)	***	----	----	----	----
Textural class	Sandy loam	Sandy clay loam	----	----	----	----	----
Organic matter (%)	0.28 (0.06)	9.27 (0.24)	***	>17	7-17	<7	<1.16
TKN (%)	0.02 (0.00)	0.72 (0.01)	***	>0.5	0.2-0.5	<0.2	<0.1
C/N ratio	11.28 (2.70)	7.51 (0.19)	NS	----	----	----	----
TP (mg kg^{-1})	14.89 (2.36)	40.36 (0.84)	***	>1000	200-1000	<200	<30.8
Exchangeable Al (cmol kg^{-1})	4.21 (0.19)	7.60 (0.43)	***	----	----	----	----
Exchangeable H (cmol kg^{-1})	0.45 (0.07)	1.34 (0.24)	**	----	----	----	----
Exchangeable K (cmol kg^{-1})	0.09 (0.00)	0.19 (0.01)	***	>0.6	0.2-0.6	<0.2	<0.15
Exchangeable Na (cmol kg^{-1})	0.06 (0.00)	0.04 (0.00)	***	>1	----	----	----
Exchangeable Ca (cmol kg^{-1})	1.67 (0.14)	0.24 (0.01)	***	>10	4-10	<4	<2
Exchangeable Mg (cmol kg^{-1})	0.13 (0.00)	0.17 (0.01)	***	>4.0	0.5-4.0	<0.5	<0.3
TEA (cmol kg^{-1})	4.66 (0.12)	8.93 (0.31)	***	----	----	----	----
ECEC (cmol kg^{-1})	6.61 (0.17)	9.58 (0.32)	***	25-40	15-25	<15	----
BSP (%)	29.43 (1.74)	6.65 (0.35)	***	>60	20-60	<20	----
Exchangeable Al (%)	63.69 (2.29)	79.33 (2.67)	***	>85	30-85	<30	----

Values in parenthesis are SDs. * $p<0.05$; ** $p<0.01$; ***$p<0.001$; NS: not significant.

TABLE 1 Topsoil mix specifications

pH	Between 5.5 and 7.0
Organic matter	Not less than 7.5 per cent
Nitrogen (N)	A minimum of 0.1 per cent
Available phosphate (P_2O_5)	69-92 µg g^{-1} of open dry soil
Exchangeable potassium (K_2O)	0.36-0.72 cmol kg^{-1} of open dry soil
Total soluble Salts	Not more than 0.01 per cent
Texture	Sand 76% ± 3% Silt 18% ± 3% Clay 6% ± 3%



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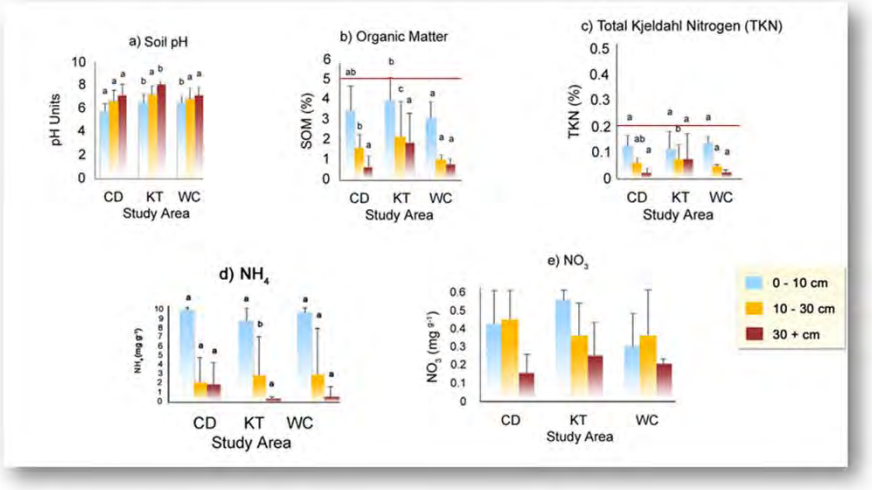
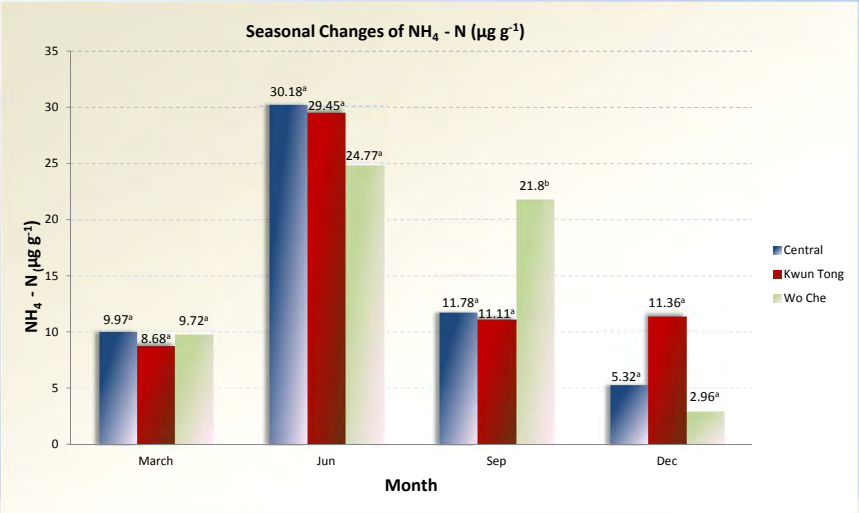
pH, Organic Matter, TKN, NH_4, and NO_3 of the planter soils



Bars sharing the same letters are not significantly different at $p<0.05$ by Duncan's Multiple Range Test.



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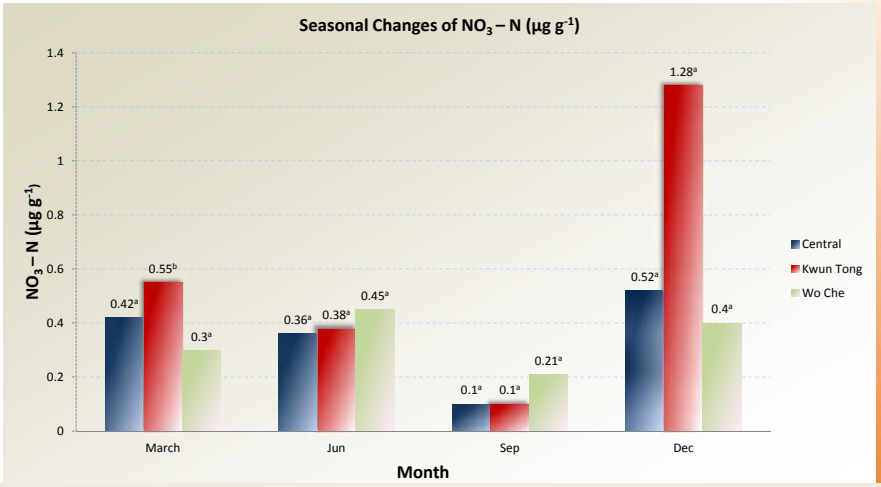

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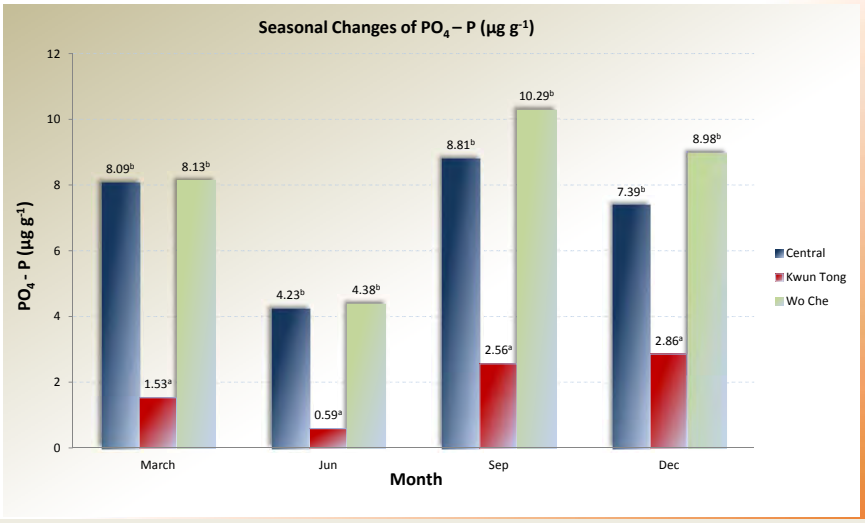

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Management of planter greenery, January – December 2000

	Central (CBD)	Kwun Tong (Industrial)	Wo Che (Residential)
a) Fertilizers			
Fertilizers	**Flowers** *Bone meal* (7% N, 7.04% P) **Trees and shrubs** *Greensome* (14% N, 11% P_2O_5, 11% K_2O) *Gold-N* (37% N)	*Greensome* (14% N, 11% P_2O_5, 11% K_2O)	*Nitrophoska* (12% N, 12% P_2O_5, 17% K_2O, 2% MgO)
Method of application	Pit application	Surface application	Pit application
Frequency	Monthly	2-3 times a year	2-3 times a year
Dose	Unknown	Unknown	Unknown
b) Irrigation			
Source	Potable water	Potable water	Potable water
Method	Manual	Manual and sprinkler	Manual
Frequency	2 times per day (morning and 3:00pm)	1-2 day intervals	Wet season: alternate day Dry season: daily
c) Insects and diseases control			
Time	Apply when detected	Apply when detected or cut off the infected branches	Apply when detected
Type	Fungicides only	NA	Insecticides only
d) Mulching			
Type	Peat moss*	Wood chips	No
Frequency	Once per year	Once per year	No
Thickness	50 mm	50 mm	NA
e) Pruning			
Time	Branch breakage Obstruct passers-by Regular pruning for shrubs (twice a year: April & Nov)	Branch breakage Obstruct passers-by Before typhoon	Branch breakage Obstruct passers-by Regular pruning for shrubs (once a year: Nov)
Wound treatment	No	No	No
f) Mid-cultivation			
Time	Once a year (Nov)	No	No
g) Other routine management	Branch breakage, littering, plant removal/flower picking: cut-off and picking	Branch breakage: cut-off	Branch breakage, littering, cut-off and picking
Extent	Not serious	Not serious	Serious

Source: Field work and interview of arboricultural staff, 1996.
***Moisture content 40-50%, water-holding capacity 45-55 %, pH 3.5, organic matter 95-99% and ash 1-5%
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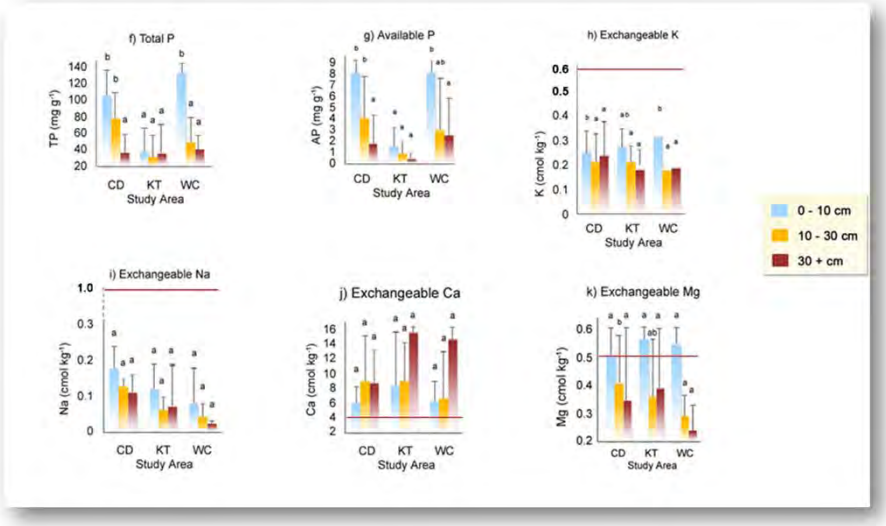
Phosphorus and Exchangeable cations of the planter soils



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Disruption of nutrient cycling

The compaction problem

Indicators of soil compaction relevant to urban trees

Attribute	Method	Critical Level	Preferred Level
(1) Porosity (% v/v)			
Total	Calculated from bulk & particle density	< 30	> 45
Air Capacity (AC)	Tension table	< 15	> 20
Available Water (AW)	Pressure plate	< 15	> 20
(2) Bulk Density (Mg/m^3)	Clod, core, or rubber balloon	> 1.6	< 1.4
(3) Penetration Resistance (MPa)	Cone penetrometer	> 2.5	< 2.0
(4) Aeration (soil air composition, % v/v)			
O_2	Membrane electrode	< 10	> 15
CO_2	Gas analyser	> 5	< 5
(5) Infiltration Capacity (cm/h)	Cylinder infiltrometer	< 5	> 10
(6) Micromorphology	Thin section and optical microscopy	Ped deformation Ped fusion Pore closure Preferred orientation of particles and pores	Discrete Peds Porous structure

Banyon tree in Kowloon Park

Conclusions

- Most urban soils are imported skeletal soils that are coarse-textured and deficient in SOM, TKN and cation nutrients.
- Current soil specifications for urban tree planting are either absent or inappropriate.
- Constraints in an urban setting
  - Small volume
  - Competition with underground utilities
  - Disruption of nutrient cycling processes
  - Compaction
  - Contamination
- Improper management (fertilizer, decompaction, post-planting soil disruption)
- Post-mortem soil analysis after the death of a tree is irrelevant if not too late.
- Best practices

  Correct recipe + Proper setting + Proper management (periodic soil test, minimum disturbance, judicial fertilizer program etc)

References

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