Compound Fertilizer Requirements for the Establishment and Early Growth of Popular Ornamental Shrubs between Road-side Trees

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Abstract

The fertilizer needs of some popular shade-loving shrubs were evaluated by a 1 year field trial. Plant growth was the same with or without inorganic fertilizer supplements irrespective of shade conditions and trial plants employed. Nutrients available from the planting mix comprising topsoil: treated sludge (3:1 v/v) appeared to be sufficient for the early growth of shade shrubs.

Introduction

Evaluation of fertilizer requirements of ornamental and landscape plants have been conducted extensively in the United States (Harris et al., 1977; Neely et al., 1970; Smith & Treaster, 1981, and van de Werken, 1981). Traditionally, fertilizer recommendations have been based on trunk caliper and in some cases on the soil surface area (Smith & Treaster, 1981). In the Parks and Recreation Department, Singapore, manuring practices are frequently, if not always, inferred and adopted from findings established for economic plants in the region. In the case of ornamental shrubs, they are often manured similarly irrespective of the edaphic factors e.g. light intensity of the habitat.

With the advent of the Garden City Campaign in Singapore, many road-side trees have been planted. The tree crowns have expanded over the years leaving much of the areas between under shade. Various suitable shade-loving shrubs have been established between trees to augment the adornment. However, empirical data pertaining to their fertilizer needs are lacking. Plants adapted to shade have metabolic rates and growth morphology which differ from those grown in full sun (Fails et al., 1982a, b & c; McClendon & McMillen, 1979 & 1982) and hence their fertilizer requisites are likely to be different. An interaction between shade intensity and fertilizer requirement has been observed for the growth of *Taxus x media* 'Hicksii' (Khatamian & Lumis, 1982). In order to eliminate guesswork from fertilizing shade shrubs, a field trial was initiated to provide the necessary information.

Materials and Methods

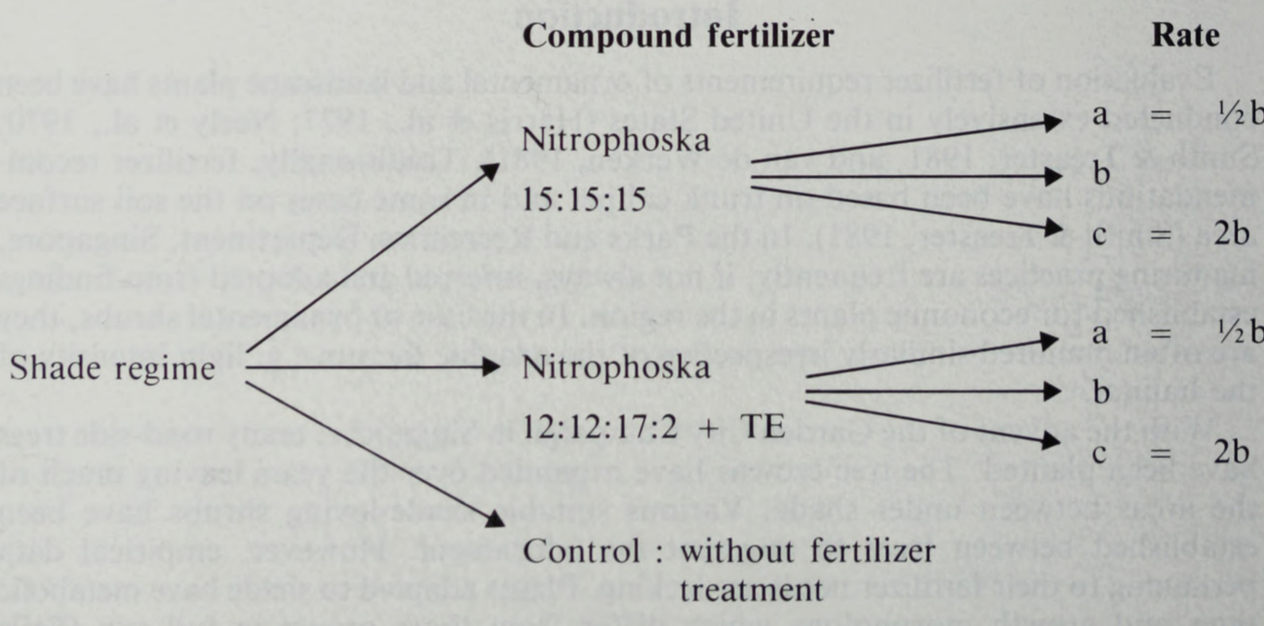
The experiment sites were on the East Coast reclaimed land under natural shade of *Acacia auriculiformis* A. Cunn. ex Benth. and *Samanea saman* (Jacq.) Merr. Three shade regimes were classified using the Li-Cor LI-185B photometer. The three shade regimes and the test shrubs selected for the different light conditions appear in Table 1. The test plants have been commonly planted under these specific shade regimes.

Table 1

Shade regimes and attendant test plants

Shade regimes	Experimental shrubs
1. Light shade Light intensity (LI) = 15,000 - 20,000 lux	a. *Ptychosperma macarthurii* (Wendl.) Nichols b. *Ixora javanica* (Bl.) DC.
2. Medium shade 10,000 < LI < 15,000 lux	a. *Philodendron selloum* C. Koch. b. *Polyscias filicifolia* L.H. Bailey
3. Dense shade 5,000 < LI < 10,000 lux	a. *Aglaonema pseudobracteatum* Hort. b. *Dracaena surculosa punctulata* Hort.

Two compound fertilizers, Nitrophoska 15:15:15 and 12:12:17:2 + TE, were tested against shrubs assigned to each shade regime at 3 rates viz: rate b = current practice of 100g per shrub at half yearly intervals, broadcasted; rate a = half the recommended dosage, and rate c = twice the recommended dosage. This is summarized for each shade regime as follows:-



The various treatments were as follows:

C = Control — without fertilizer treatment.
1a = Nitrophoska 15:15:15 applied at rate a (50g per shrub at half yearly intervals).
1b = Ibid but at rate b (100g per shrub at half yearly intervals).
1c = Ibid but at rate c (200g per shrub at half yearly intervals).
2a = Nitrophoska 12:12:17:2 + TE applied at rate a (50g per shrub at half yearly intervals).
2b = Ibid but at rate b (100g per shrub at half yearly intervals).
2c = Ibid but at rate c (200g per shrub at half yearly intervals).

Each treatment was replicated 5 times.

Planting holes of dimension 0.5m × 0.5m × 0.5m were made and backfilled with a sandy clay loam topsoil premixed with treated sludge in the ratio 3:1 v/v (topsoil : sludge). Uniform plants of each species were laid out in a randomized block design under the appropriate shade regime, 1.5m apart from one another. Plants were left to establish for two weeks before fertilizer treatment was initiated. Similar to routine field fertilizer application, fertilizer was broadcasted around the plants at a safe distance from the trunk to avoid burn injury.

The trial was conducted for a year. A regular pest control programme was maintained throughout the trial period. Snails were the most damaging pest but these were kept at bay with 'Snailex'. Whenever necessary, trees were pruned to maintain the shade conditions required.

After 1 year, trial plants were harvested, washed with a non-ionic detergent and finally rinsed with distilled water. Dry matter accumulations were determined and recently matured leaves separated for the analysis of the N, P and K contents. Composite soil samples comprising three 0–6'' soil cores were collected for the analysis of total N, Bray P and ammonium acetate exchangeable K.

Total N was determined by the micro-Kjeldahl method, phosphorus by the molybdenum blue method and potassium by flame photometry (Anonymous, 1980; Chapman & Pratt, 1961; Hesse, 1971).

Results and Discussions

Results were statistically analysed by the Duncan Multiple Range Test and tabulated (Tables 2–7).

Irrespective of the shade regimes and the attendant plants investigated, there was no apparent relationship between dry matter yield and fertilization. With *Aglaonema pseudobracteatum* (Table 3), *Polyscias filicifolia* (Table 4) and *Ptychosperma macarthurii* (Table 6), treatment 2c (12:12:17:2 + TE at 200g per shrub at half yearly intervals) appear to have retarded early growth.

The N and K contents in the soil did not increase consistently with higher fertilizer rates probably partially due to leaching and run-off losses. However, in some cases, the soil P content was found to increase significantly with increasing fertilizer rates (Tables 3 & 6). P accumulation in the soil was probably due to its low mobility in the soil and low consumption by the plants.

Foliar N, P and K contents did not reflect the levels of these elements in the soil i.e. higher levels of such elements in the soil did not necessarily lead to their greater accumulation in the leaves.

Regardless of shade intensities, trial plants, fertilizer types and rates of application, the untreated controls appeared to perform similarly as the treated counterparts both visually and based on dry matter accumulation (Tables 2–7). The findings of the present investigation indicate that the fertilizer requirements for the early growth of ornamental shade shrubs were low. As a corollary, Othieno (1983) reported that the N, P and K contents of mature tea leaves were reduced under shade. The nutrient needs of shade shrubs appeared to be adequately met by the nutrient elements furnished by the sludge incorporated initially into the topsoil.

Conclusion

Shade-loving shrubs could maintain healthy growth on topsoil supplemented with sludge. Additional inorganic fertilizer did not further enhance growth in the first year. At higher rates, inorganic fertilizer could become detrimental to plant growth.

Table 2

Dracaena surculosa punctulata (Dense shade)

Treatment	C	1a	1b	1c	2a	2b	2c
Dry matter (g)	6.72d	2.94d	5.91d	5.06d	6.52d	5.74d	6.65d
Foliar N (%)	2.42e	1.81e	2.19e	2.69e	2.47e	2.55e	1.63e
Foliar P (%)	0.06f	0.09f	0.11f	0.19f	0.10f	0.13f	0.13f
Foliar K (%)	2.43g	2.42g	3.30g	4.15g	2.74g	4.54g	2.82g
Soil Total N (%)	0.31h	0.39h	0.37h	0.34h	0.37h	0.42h	0.43h
Soil Available P (ppm)	270j	606j	458j	1062j	590j	785j	579j
Soil Exchangeable K(me%)	0.25k	0.26k	0.39k	0.33k	0.28k	0.25k	0.31k

The treatments have reference in Table 1.

Values are means of 5 replicates.

Values in each row if not followed by the same letter are significantly different as judged by the DMR test at $P < 0.05$.

Table 3

Aglaonema pseudobracteatum (Dense shade)

Treatment	C	1a	1b	1c	2a	2b	2c
Dry matter (g)	12.14d	11.15d	11.29d	11.86d	9.22d	12.76d	8.82d
Foliar N (%)	2.34e	2.06e	2.72e	1.72e	2.27e	3.14e	2.25e
Foliar P (%)	0.32f	0.43f	0.41f	0.27f	0.27f	0.36f	0.38f
Foliar K (%)	5.93g	5.75g	5.60g	4.92g	5.48g	5.65g	5.81g
Soil Total N (%)	0.25h	0.37h	0.43h	0.33h	0.36h	0.34h	0.40h
Soil Available P(ppm)	157j	545j	882j	1405k	435j	907jk	904jk
Soil Exchangeable K(me%)	0.30ln	0.33lm	0.25l	0.57mn	0.24l	0.33lm	0.60m

The treatments have reference in Table 1.

Values are means of 5 replicates.

Values in each row if not followed by the same letter are significantly different as judged by the DMR test at $P < 0.05$.

Table 4
Polyscias filicifolia (Medium shade)

Treatment	C	1a	1b	1c	2a	2b	2c
Dry matter (g)	26.19ef	54.44d	44.55df	31.07ef	41.03dfg	32.27ef	20.93eg
Foliar N (%)	2.66h	2.58h	3.12h	2.44h	2.86h	2.76h	2.81h
Foliar P (%)	0.33j	0.22j	0.17j	0.18j	0.18j	0.26j	0.13j
Foliar K (%)	3.90k	3.68k	2.75km	3.78k	3.88k	3.44km	2.45lm
Soil Total N (%)	0.32n	0.31n	0.29n	0.33n	0.28n	0.33n	0.28n
Soil Available P(ppm)	428p	315p	248p	372p	609p	521p	238p
Soil Exchangeable K(me%)	0.18q	0.20q	0.20q	0.36q	0.26q	0.24q	0.26q

The treatments have reference in Table 1.
Values are means of 5 replicates.
Values in each row if not followed by the same letter are significantly different as judged by the DMR test at $P < 0.05$.

Table 5
Philodendron selloum (Medium shade)

Treatment	C	1a	1b	1c	2a	2b	2c
Dry matter (g)	29.36d	30.60d	33.68d	23.74d	16.53d	35.35d	45.00d
Foliar N (%)	3.15e	2.77e	3.55e	2.06e	4.06e	2.53e	1.97e
Foliar P (%)	0.20f	0.30f	0.24f	0.24f	0.31f	0.29f	0.27f
Foliar K (%)	3.21g	3.30g	3.41g	3.94g	4.11g	3.29g	3.22g
Soil Total N (%)	0.34h	0.35h	0.28h	0.34h	0.31h	0.50h	0.32h
Soil Available P(ppm)	1016j	1238j	934j	1520j	931j	1734j	1380j
Soil Exchangeable K(me%)	0.30k	0.41k	0.36k	0.37k	0.36k	0.39k	0.38k

The treatments have reference in Table 1.

Values are means of 5 replicates.

Values in each row if not followed by the same letter are significantly different as judged by the DMR test at $P < 0.05$.

Table 6

Ptychosperma macarthurii (Light shade)

Treatment	C	1a	1b	1c	2a	2b	2c
Dry matter (g)	119.75d	136.75d	98.50d	115.75d	124.13d	126.25d	89.88d
Foliar N (%)	2.44e	2.39e	2.51e	2.32e	2.10e	2.81e	2.26e
Foliar P (%)	0.15f	0.15f	0.13f	0.18f	0.14f	0.16f	0.14f
Foliar K (%)	1.69g	1.83g	1.94g	1.92g	1.84g	1.78g	1.74g
Soil Total N (%)	0.31h	0.35h	0.39h	0.34h	0.34h	0.28h	0.31h
Soil Available P(ppm)	231j	381jm	920kl	1051k	523jlm	472jlm	790km
Soil Exchangeable K (me%)	0.30n	0.37n	0.34n	0.44n	0.39n	0.44n	0.42n

The treatments have reference in Table 1.

Values are means of 5 replicates.

Values in each row if not followed by the same letter are significantly different as judged by the DMR test at $P < 0.05$.

Table 7
Ixora javanica (Light shade)

Treatment	C	1a	1b	1c	2a	2b	2c
Dry matter (g)	123.67d	136.17d	114.83d	85.33d	111.67d	102.17d	101.33d
Foliar N (%)	1.93e	2.44e	1.71e	1.54e	2.01e	1.50e	2.11e
Foliar P (%)	0.19f	0.13f	0.13f	0.13f	0.15f	0.13f	0.17f
Foliar K (%)	1.97g	2.19g	2.09g	2.05g	2.14g	2.00g	2.00g
Soil Total N (%)	0.36h	0.39h	0.31h	0.33h	0.34h	0.33h	0.29h
Soil Available P(ppm)	229j	325jk	543kl	494jk	285jl	614k	621k
Soil Exchangeable K(me%)	0.32m	0.31m	0.35m	0.40m	0.37m	0.50m	0.51m

The treatments have reference in Table 1.
Values are means of 5 replicates.
Values in each row if not followed by the same letter are significantly different as judged by the DMR test at $P < 0.05$.

This study tends to suggest that if sludge is used in the planting mix for shade shrubs, the latter can thrive well for the first year without any supplement of inorganic fertilizer. However, their long-term fertilizer requirements need to be elucidated by further field experimentation.

Literature Cited

Anonymous. (1980). Handbook on reference methods for soil testing. The Council on Soil Testing and Plant Analysis, University of Georgia, USA.

Chapman, H.D. and Pratt, P.F. (1961). Methods of analysis for soils, plants and waters. Division of Agricultural Sciences, University of California, USA.

Fails, B.S., Lewis, A.J. and Barben, J.A. (1982a). Net photosynthesis and transpiration of sun- and shade-grown *Ficus benjamina* leaves. *J. Amer. Soc. Hort. Sci.*, 107, 758–761.

Ibid. (1982b). Anatomy and morphology of sun- and shade-grown *Ficus benjamina. J. Amer. Soc. Hort. Sci.*, 107, 754–757.

Ibid. (1982c). Light acclimatization potential of *Ficus benjamina. J. Amer. Soc. Hort. Sci.*, 107, 762–766.

Hesse, P.R. (1971). A textbook of soil chemical analysis. William Clowes & Sons Limited, London.

Khatamian, H. and Lumis, G.P. (1982). Influence of shade, media and fertility on growth of *Taxus. J. Arbor.*, 8, 247–249.

McClendon, J.H. and McMillen, G.G. (1982). The control of leaf morphology and the tolerance of shade by woody plants. *Bot. Gaz.*, 143, 79–83.

Othieno, C.O. (1983). Studies on the use of shade in tea plantations in Kenya. I. Effects of nutrient uptake and yield of tea — Preliminary results. *Tea,* 4, 13–20.

Smith, E.M. and Treaster, S.A. (1981). Fertilizing trees in the landscape: A 9-year evaluation. Ohio Agricultural Research and Development Center, *Research Circular* 263, 11–13.

van de Werken, H. (1981). Fertilizing and other factors enhancing the growth rate of young shade trees. *J. Arbor.* 7, 33–37.