Cashew Nuts in North Queensland Respond to Phosphorus and Sulfur Fertilizers

By Noel J. Grundon

Cashew nuts prefer a seasonally wet/dry, tropical climate and represent a new horticultural opportunity in northern Australia. North Queensland, the Northern Territory, and northern Western Australia have large areas with soils suitable for cashew. CSIRO Land and Water has initiated research at Dimbulah, North Queensland, to investigate the fertilizer requirements of the crop.

The research programme focused on (a) providing site-specific recommendations of the optimum fertilizer nutrient rates for sustainable economic yields of cashew nuts, and (b) minimising long-term damage to the soil and water resources of the area from high inputs of fertilizer nutrients. Preliminary glasshouse nutrient omission studies identified deficiencies of nitrogen (N), phosphorus (P), and sulfur (S) in cashew seedlings, while observations of nutritional disorders on field-grown trees indicated that potassium (K) may be inadequate for mature trees in the field.

Fertilizer field trials were initiated using five rates of P, K, and S, commencing with four-year-old grafted cashew trees planted at a density of 200 trees/ha (i.e., 8 m row spacing; 6 m spacing within rows). Trees were irrigated when required during their flowering and fruiting season of May to December, which coincided with the seasonally dry period. With the exception of the nutrient being tested, all trees received adequate levels of all nutrients as surface dressings within the dripline of the tree. All P fertilizer was applied in March, towards the

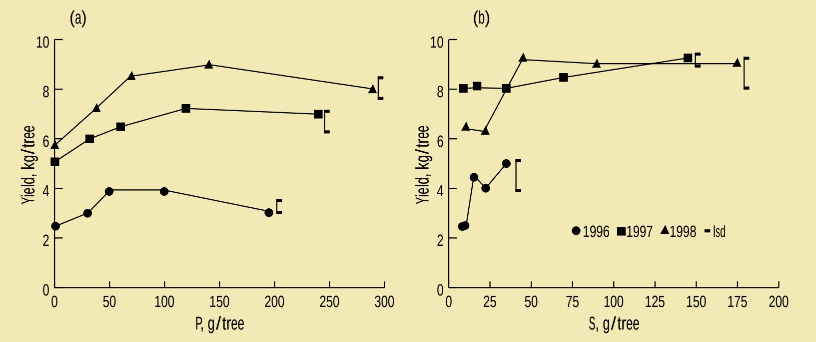

Figure 1. Effects of P (a) and S (b) fertilizers on yield of saleable cashew nut-in-shell at Dimbulah, North Queensland.

Table 1. Selected soil properties of top-soil (0 to 30 cm; sandy loam) and sub-soil (80 to 100 cm; clay loam) from under trees receiving farmer's normal low inputs of fertilizers at Dimbulah, North Queensland.

Depth, cm	pH[a]	EC[a], mS/cm	Org. C, %	N[b], %	Exchangeable cations, cmol(+)/kg Na	K	Ca	Mg	SO_4-S[c]	P[d]	Cu[e] mg/kg	Mn[e]	Zn[e]
0-30	6.1	0.01	0.24	0.004	0.01	0.09	1.11	0.25	1.1	3	0.1	16.5	0.4
100-150	6.5	0.01	0.07	0.001	0.01	0.11	0.87	0.74	2.0	3	0.2	4.0	1.2

[a]1:5 soil:water; [b]total Kjeldahl N; [c]calcium phosphate-extractable; [d]bicarbonate-extractable; [e]DTPA-extractable

end of the wet season, while the remaining fertilizers were applied as three equal splits in March, June and September. The field experiment was conducted over three years, beginning in 1996, and fertilizer rates were increased each year to accommodate increased tree growth with increased maturity.

The impact of high fertilizer input on the soil resources was examined both by sampling the soil profile before fertilizer application and after fertilizer had been applied for two years. To provide a comparison, soil samples were also collected from virgin open forest adjacent to the cashew plantation and from under trees receiving the farmer's normal fertilizer regime.

Response to P, K and S Fertilizers in the Field – Applications of P (up to 288 g/tree/year) and S (up to 176 g/tree/year), significantly (probability level = 5 percent) increased yield of saleable cashew nut-in-shell (cashew nuts sold on the world market with kernel weights greater than the minimum of 0.91 g/kernel). Application of K, up to 3000 g/tree/year, did not increase yield. As the trees became more mature, the optimal rate of P and S for maximum yield increased each year, from about 90 g/tree/year to 150 g/tree/year in the case of P and from about 35 g/tree/year to 50 g/tree/year in the case of S (**Figure 1**).

Economics of Fertilizer Use – Cashews are traditionally grown with no or very low fertilizer input. In Australia, fertilizer use is normally restricted to soil dressings of N and K with occasional foliar sprays of zinc (Zn) costing about 20 cents to 25 cents/tree/year. Excluding fertilizer costs, total variable costs for a 200 ha cashew plantation at Dimbulah have been estimated to be $5.05/tree/year.

The economics of fertilizer use were examined by calculating gross margins. Economic inputs included a farm-gate price of $1.63/kg nut-in-shell and respective yields from trees receiving the farmer's normal fertilizer regime or the trial's higher-than-normal P and S fertilizer rates. The gross margins obtained from the farmer's normal fertilizer regime were calculated to total $7.20/tree for the three years of the field study, or an average gross margin of $2.40/tree/year. In the experimental trees, the highest gross margins for 1996, 1997 and 1998 were obtained with 96, 120, and 144 g P/tree/year, and 34, 144 and 44 g S/tree/year, respectively. Averaged over the three years of this study, the gross margins per year were $3.71/tree/year for the P fertilization and $5.98/tree/year for the S fertilization. Thus, higher-than-normal fertilizer rates have a clear economic advantage over the farmer's normal rates of between $1.31 and $3.58/tree/year. These rates of return could lead to increased incomes of between $260 and $720/ha/year at a plant density of 200 trees/ha.

Impact of Normal and Higher-than-Normal Fertilizer Rates on Soil Resources – The soil chemical properties in the virgin open forest adjacent to the cashew plantation and the soil profile under the cashew trees receiving the farmer's normal low input rates of fertilizers (**Table 1**) were very similar and showed that low inputs of fertilizers over a 10-year period had little effect on the soil resources of the production area.

When the higher-than-normal rates of fertilizers were applied in 1996 and again in 1997, and the soil was sampled in March 1998, there were marked changes in soil pH, soil electrical conductivity, exchangeable cations, and bicarbonate-extractable P. In the surface horizons, soil pH increased by 1.4 units to 7.5 because dolomite was used as the source of calcium (Ca) and magnesium (Mg). Of greater concern was a 1.2 unit decrease in soil pH to 5.3 at depths below 100 cm. Leaching of soluble fertilizer salts under the influence of heavy tropical rains and irrigation was indicated by large increases in exchangeable sodium (Na) [0.15 cmol (+)/kg] and exchangeable K [0.57 cmol (+)/kg] and a three-fold increase in electrical conductivity (0.03 mS/cm) in the 100 to 150 cm horizon. Levels of exchangeable Ca and Mg and DTPA-extractable copper (Cu), manganese (Mn), and Zn had not increased at depth, but their levels were slightly higher in the top-soil (0 to 30 cm), suggesting that fertilizer residues containing these nutrients were accumulating in surface horizons. There were similar but more marked accumulations of P from fertilizer residues in surface horizons. Levels in the 0 to 15 cm horizon had risen from 3 mg/kg in 1996 to 33 mg/kg in 1998.

Conclusions

Initial findings of this research indicate that higher-than-normal inputs of fertilizers increase cashew nut yields and were clearly economically sustainable in cashew plantations in North Queensland. However, the findings need to be verified in different locations and over a longer time frame under actual commercial grower practice.

Of concern in the longer term is the sustainability of the soil resources of the production areas. There is a need to continue to monitor the impact of higher inputs of fertilizers, especially in terms of increased soil acidity and electrical conductivity in the sub-soil and the accumulation of large residues of P in surface horizons. **BCI**

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