Literature Review – Fertilisers and Poplars.

Adegbidi et al 2000
Biomass and nutrient removal by willow clones in experimental bio-energy plantations in NY state. Biomass and Energy 20 (2001): 399-411

Short-rotation intensive cultures (SRIC) have higher rates of nutrient removal by harvest than medium-rotation or mature forests. The higher bark-wood ratio of the younger stems in SRIC systems and the higher nutrient concentration of the bark are important factors contributing to the higher nutrient removal. This was a long term study of 15+ years for mature forest. Harvesting was after leaf-fall. Stems and poles were harvested. Nutrient content was assessed.
Experiments:
1 2 x 6 factorial fertilised / unfertilised x 6 clones (5 willow, 1 poplar)
2 2 x 3 x 3 2 willow clones x 3 spacings x 3 dormant season harvest cycles (1 yr, 2 yrs, 3yrs)
3 2 x 2 irrigated / non-irrigated x 2 willow clones

Average annual removal of nutrients: non-fertilised hybrid poplar clone had the highest removals of P and K. Fertilisation significantly increased removals of N, P, and K but not Ca or Mg. The shortest harvest cycle had the highest removal of nutrients for one clone but not the other. Irrigation increased biomass production by x 2-3.
The study evaluated nutrient use efficiency for the various trials. The results need to be studied closely. In general, irrigation did not affect NUE. Clone affected NUE, as did fertilisation.
The significant effects of fertilisation on the removal of N, P and K suggested those elements added through fertilisation were used for increased growth. Irrigation increased nutrient removals by means of increased biomass production.
Reported that annual removals of P are much lower than N or K, e.g. 25-32, 4.5–5.5, 23-30, and 51-66 kg/ha for N,P,K and Ca respectively (stored as biomass).
Under fertilisation NUE appeared to drop. When biomass crops are used for the objective of nutrient management, a combination of high yielding clones with low NUE in a short harvest cycle is most appropriate. = Good Thought
due to their relatively high nutrient requirement, willow biomass crops have potential for successful use in systems design to manage nutrient runoff from agricultural fields and wastewater.

Jug, A et al 1999. Short-rotation plantations of balsam poplars. Forest Ecology and Management **121**: 67-83.

Used Populus trichocarpa and P. tremula x P. tremuloides for a fertiliser trial. Planted as cuttings. Evaluated the effect of various fertiliser regimes on foliar nutrient levels, and the level of exported nutrients following harvest at three different sites. N P K Ca Mg used.
They found that fertilising produced no benefit to foliar nutrient values or accelerated growth and concluded that the trees were able to accumulate sufficient nutrients perhaps due to previous fertilising and liming. Correlation analyses between foliar N and P, on the one hand , and tree height and growth, on the other, revealed only moderate relationships for N and the aspen (P. t.) whereas the correlations were not significant for P. d.. Determined that growth was limited by insect attack and water shortage. Export levels were N:P:K:Ca:Mg 55:10:35:70:5 kg/ha/yr sufficiently supplied from the residual nutrient base without the need for additional fertiliser. Hi-lights the need to determine soil nutrient status before applying fertiliser. verdict – interesting paper, and useful.

Nakos, G. 1979. Fertilisation of poplar clones in the nursery. Plant and Soil **53**, 67-79

Used 4 poplar clones. Of the fertiliser nutrients N, P, K, and Mg only N improved heights of all clones significantly. Fertilisers were applied only during the first growth period. Soil was cultivated or irrigated to ensure good fert. mixing. Cuttings were planted at 40 cm and rows were 1 m apart. Fertilising with P alone had no or a negative effect on height cf control. .Fertilisation with NPK raised leaf concentrations of N but not P or K. Ammonium Nitrate at 200 kg N /ha gave the best height growth. Separate applications (2x, 3x) did not improve growth significantly. in either the first or second growth period, but was thought to be better during the first growth period possibly through more efficient use of N fertiliser by tree roots and reduction of N to drainage.

Lodhiyal and Lodhiyal. 1997. Nutrient cycling and nutrient use efficiency …….
Annals of Botany 79: 517-527

Studied high density – short rotation poplar (P. deltoides Marsh) raised on low lying high water table land next to the Himalayan foothills. Intensive study in 1-4 yr trees of nutrient levels in foliage twigs, branches, bole, coarse roots, fine roots. Observed the soil nutrient conc. decreased with plantation age. Suggested the shorter rotation cycle combined with the high density of trees may help in keeping the soil nutrient level intact, as nutrient return through litter fall approx. compensates for depletion through nutrient uptake from the soil. Get production of stems with out too much use of nutrients.

van den Dressche, R. 1999. First-year growth response of 4 P. trichocarpa x P. deltoides clones to fertiliser placement and level. Can. J. For. Res. 29: 554-562

Fertiliser banding was along the row 20cm wide and 25cm away from the row and then incorporated into the soil by cultivation. Placing was into 2 or 4 holes 12cm deep, made with a planting dibble at 15 cm from the cutting. Banded levels were 0, 100, 200 kg/ha of 18.40.0 NPK + 0.5% Zn, 05% Cu and 1.5% S, and placed levels were 0, 25, 50 kg/ha of the same. there was significantly greater response to placed than to banded fertiliser treatment. (about 2x as effective in increasing stem volume) Response appeared to be largely to N. There were ???? about why uptake of P was so low. It was possibly a consequence of urea changing the pH. NUE was higher with placed fertiliser. there were clonal response differences though general pattern was the same.

SUMMARY:

Poplars are shown to be NUE for the macronutrients N, K, P,Ca and Mg. in widely variable geographical and soil conditions. When cropped for poles poplars are economical users of soil nutrients, returning a major % of nutrients taken up during the growing season as leaf litter, twigs and branches to the soil. Poplars are heavy users of N and to a lesser extent K, but do not store large amounts of P. Some studies have shown that poplars grown with NK fertiliser supplements grow as well as poplars grown with NPK fertiliser supplements. Nutrient use is heavier in the second year of growth probably as a consequence of growth and a more extensive rooting system. Where poles are being grown from stool beds with established rooting systems, the use will be more dependent on above ground growth. One study showed no additional benefit to poplar height from the application of NPK fertiliser, emphasising the importance of testing soil for nutrient levels prior to applying amendment. There will be $savings and a reduction in N leaching, particularly where irrigation is applied. At Aokautere P levels have increased with fertilisation to levels that are now probably well above requirements for poplar pole production. It would seem appropriate to do a fertiliser field trial that applies NPK, NK to set levels + control.
NK is available commercially as a slow release mix, Azolon GreenKeeper ($82.70 + gst / 25 kg).