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Finding just the right recipe: nutrient requirements on Christmas Island

There is no history of large-scale agriculture on Christmas Island. As a result, there is a heavy reliance on imported produce.

In response, MINTOPE (Mining to Plant Enterprise), based at Murdoch University, together with its partners, Christmas Island Phosphates and the Australian Government (Department of Infrastructure and Regional Development and the Australian Research Council), are investigating methods of introducing agriculture to the island following mining.

A range of agricultural species are being grown on old mine sites on the island. Nutrient field trials undertaken in 2015 (see Bulletin 3.02) clearly showed that potassium is a major limiting nutrient for legumes (Figure 1), and nitrogen is limiting cereal growth.

Following on from the 2015 trials, and to develop recommendations specifically for the conditions on Christmas Island, two field trials were established in early 2016. In the first, new, slow-release potassium fertilisers were developed together with Troforte Innovations. Given the high rainfall on the island (~2000mm/yr) and thus the potential to leach fertilisers through the soil profile, it was suspected that a slow release fertiliser would prove to benefit plant growth and be more efficient over a longer period. In the second trial, a range of nitrogen levels were applied to one of the cereal crops to determine optimum requirements for growth.

FIGURE 1 Symptoms of potassium deficiency on Lablab. Note the yellowing (chlorosis) and browning (necrosis) between leaf veins, and brown scorching of leaf margins and tips

Methods and results

In the first trial, three types of slow-release fertilisers were created and applied, including KCl (two month release), K_2SO_4 (three month release) and K_2SO_4 (nine month release). In order to robustly test these new fertilisers, they were compared with a control (containing no fertiliser) and very high and low potassium treatments, composed of the standard K_2SO_4 powder. The study species chosen was Lablab (*Lablab purpureus* L.), which was planted in a replicated design (40 plants/plot x 4 plots/treatment = 24 plot x 3 sites).

Biomass results after five months of growth showed that all treatments improved plant growth over the control (Figures 2 and 3), and that the K_2SO_4 (9 month release) was particularly beneficial.

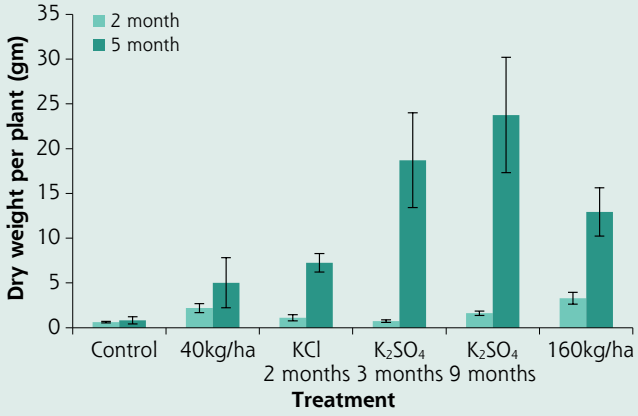

FIGURE 2 Lablab biomass (dry weight per plant, gm) after two and five months of growth at Airport 2 site with treatments: control, 40kg/ha of the standard K_2SO_4 powder, slow release K fertilisers (KCl three month release, K_2SO_4 three month release, K_2SO_4 9 month release) and 160kg/ha of the standard K_2SO_4 powder

FIGURE 3 Lablab after two months of growth in the treatments*

* 1.5m plots are bounded by white-tipped stakes with 1m between plots). From the nearest plot the treatments are: control, 40kg/ha of the standard K_2SO_4 powder, slow release K fertilisers (KCl, K_2SO_4) and 160kg/ha of the standard K_2SO_4 powder

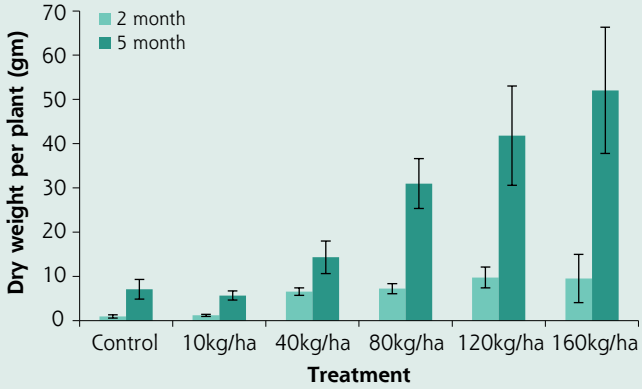

FIGURE 4 (Top) Sorghum biomass (shoot dry weight g/ plant) after two and five months of growth in response to different rates of nitrogen (as urea). (Bottom) Differences in shoot yields were clearly visible in the sorghum harvested at five months with treatments from left to right: control, 10, 40, 80, 120, 160kg/ha urea

This fertiliser produced nearly twice as much biomass as the 160kg control.

In the second trial, increasing rates of urea (nitrogen: CH_4N_2O) were applied to sorghum (*Sorghum bicolor*), which was planted in a replicated design (40 plants/plot x 4 plots/ treatment = 24 plots) in order to robustly test biomass accumulation in relation to N supplied. After five months of growth the control, 10kg/ha and 40kg/ ha urea (N) showed very poor biomass levels compared with the treatments with higher levels of urea (Figure 4).

Conclusions and recommendations

Our nutrient field trials on Christmas Island have shown that slow release potassium fertilisers and high levels of nitrogen can produce significant increases in biomass in legumes and cereals, respectively. Future trials will investigate slow release nitrogen fertilisers for cereals. We hope to deploy these after strong legume N fixation, to complement the N mineralisation rates. Optimising nutrient input for agriculture on Christmas Island will minimise nutrient runoff and waste while maximising crop yield — with associated social, economic and environmental benefits. ■

More information

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