

Thesis title Nitrogen Fixation in Red Kidney Bean (Phaseolus vulgaris L.) cv. Mokcham

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M.S. Agriculture (Agronomy)

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Abstract

This thesis research project, in three experiments, has attempted to evaluate the potential contribution from nitrogen fixation in Red Kidney Bean (Phaseolus vulgaris), a crop recommended for opium replacement in the highlands of Northern Thailand. As nitrogen fertilization is commonly recommended for red kidney bean, effects of nitrogen fertilizer on nitrogen fixation were also examined. Nitrogen fixation was estimated with the xylem sap method.

The first experiment, carried out at Chang Kian Highland Research Station, Faculty of Agriculture, Chiang Mai University, examined effects of nitrogen fertilizer (70 kg N/ha)

and rhizobial inoculation (commercial inoculant and UMR 1165) on nitrogen fixation and yield of a red kidney bean cv. Mokcham in a highland environment (1,200 m). The experiment was a completely randomized block with four replicates. Without inoculation, Mokcham nodulated freely, it had about the same amount of nodule dry weight as when inoculated with a commercial inoculant or with an improved strain, UMR 1165. An application of 70 kg N/ha as urea at 14 days after sowing had no effect on nodulation. In all treatments nodule dry weight declined sharply after full pod set. Inoculation had no effect on nitrogen fixation. Nitrogen fertilizer application, on the other hand, depressed nitrogen fixation. The effect was slight at full bloom (R_2), but became more severe from full pod set (R_4) to full seed growth (R_6), when the bean with nitrogen fertilizer was deriving only half of its nitrogen from fixation compared with > 80% when nitrogen was not applied. Uninoculated and unfertilized bean yielded 1,528 kg/ha of grain, which was slightly less than when it was inoculated (1,754-1,852 kg/ha) or given fertilizer nitrogen (1,923 kg/ha).

The second experiment, carried out at Multiple Cropping Center Research Station, Faculty of Agriculture, Chiang Mai University, evaluated effects of inoculation and nitrogen fertilizer on nitrogen fixation and yield of Mokcham on land that has not previously been inoculated with Rhizobium leguminosarum biovar phaseoli. The experiment was a split plot, with inoculation (0, UMR 1899) in main plots and six rates of nitrogen fertilizer (0, 25, 45, 81, 146, 262 kg N/ha) in sub plots. There were four replicates. Without inoculation the beans were not nodulated. Analysis of ureides in the xylem sap, however,

indicated very low levels of nitrogen fixation in nodulated plants. Responses to nitrogen fertilizer, on the other hand, were observed in plant dry weight to 81 kg N/ha and total nitrogen uptake to 262 kg N/ha. Seed yield was increased by > 62% by the first 25 kg N/ha of fertilizer nitrogen, but further increases in the rate of nitrogen fertilizer had only slight effects on seed yield.

As some factors appeared to be limiting nitrogen fixation of nodulated bean in the field in experiment 2, experiment 3 was conducted to determine nitrogen fixation potential of Mokcham under optimum root condition and to examine effects of combined nitrogen on nitrogen fixation. The experiment, conducted in a sand culture in the Screenhouse, Faculty of Agriculture, Chiang Mai University, was a split plot, with inoculation (0, UMR 1899) in main plots and for levels of combined nitrogen (0, 2.5, 5 and 10 mM) in sub plots, in three replicates. The bean was grown in pots (diameter 30 cm) containing washed river sand, watered twice daily with complete nutrient solution with different levels of combined nitrogen. Each plot consisted of 4 separate pots for four harvests at V_4 , R_2 , R_4 and R_6 . Without inoculation, Mokcham nodulated and its nodule dry weight is not different from inoculated with strain UMR 1899. Both nodule dry weight declined sharply after R_4 . Responses to nitrogen fertilizer, the beans increased dry matter and nitrogen accumulation up to the application of 10 mM. On the other hand, nitrogen application depressed nitrogen fixation. Application of nitrogen at 2.5 mM, beans derived nitrogen from fixation 48% compared with 80% when nitrogen was not applied.