IFS - PRO - 10

Comparison of Rhizobial Inoculants and Fungal-Rhizobial Biofilms on Nodulation, N-Yield, Growth and Development of Green Gram *(Vigna radiata)*

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Nitrogen, an essential nutrient for plant growth, is supplied mainly by chemical fertilisers in cultivation of crops. The natural process of biological nitrogen fixation can be utilised as an alternative for chemical N-fertilisers. The objective of this research was to compare the effects of rhizobial inoculants and a fungal-rhizobial biofilm on nodulation, N-yield, growth and development of green gram.

The study included four different steps: 1) Development of rhizobial inoculants using four highly infective and effective rhizobial strains for green gram (BG_7, GG_3, GG_8 and GG_{12}) identified from previous studies, 2) Development of biofilms using all the four strains of rhizobia with two separate species of fungi, *Penicillium* sp. and *Acremonium* sp. isolated from soil, 3) Screening the nitrogenase activity of the biofilms to select the most suitable biofilm, and 4) Testing the infectivity and effectivity of the rhizobial and biofilm inoculants under aseptic conditions in a pot experiment with 2 plants per pot, 5 pots per treatment.

The results indicated the highest nitrogenase activity in the *Penicillium-Rhizobium* biofilm with the combined strains of BG_7, GG_3, GG_8 and GG_{12}. Hence, this biofilm was selected for pot experiments. The four individual rhizobial isolates and the biofilm formed root nodules six weeks after inoculation. The highest number of nodules (average of 36 per plant) and the highest nodule dry weight per plant (0.0335 g) were observed with the biofilm treatment. The biofilm was therefore rated as the most infective inoculant. No nodulation was observed in the N- and N+ controls showing the complete destruction of indigenous rhizobia in the sterilised soil used. While the growth performance of the plants inoculated with rhizobial isolates was significantly higher than that of N-control, the growth of the N+ treated plants was equivalent to that of the highest growth shown by biofilm treated plants. This indicates that the growth differences observed were primarily due to N-nutrition. Highest nodulation by the biofilm has enhanced nitrogen fixation and increased growth performance of these plants. The N-yields and flowering of the plants inoculated with the rhizobial isolates were significantly higher ($p< 0.05$) than those of N- control. This indicates enhanced N_2-fixation due to rhizobial inoculation. Both N-yield and the reproductive performance were highest in the biofilm treatment, indicating further improvement of the symbiosis by the biofilm.

Therefore, it was concluded that rhizobial inoculants enhance symbiotic N_2-fixation in green gram and this was further improved by inoculating with biofilmed biofertiliser which had an effect equivalent to the plants that received the full recommended level of chemical N-fertiliser (N+ treatment).