Tropical Agricultural Research and Extension, 2 (2):132-134, 1999

Short Communication
Effect of peat and coir dust - based rhizobial inoculants on the nodulation, plant growth and yield of Soybean (*Glycine max* [L.] Merill) cv PB 1

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Accepted 08 December 1999

ABSTRACT

Proper inoculation of legumes with effective rhizobia is a significant agency for improving crop productivity and soil fertility. Peat has been used as the main carrier for legume inoculants for a long time. Present study demonstrates that coir dust, a by-product of coconut industry is superior to Sri Lankan peat as a carrier for rhizobial inoculants.

Key words: Rhizobial inoculants, Peat, Coir dust, Carrier, Soybean, *Glycine max*

The successful exploitation of the legume-*rhizobium* symbiosis requires the presence in soil of appropriate rhizobial strains that are highly effective in N_2 fixation. Where these are either absent or ineffective, rhizobial inoculation is necessary to ensure N_2 fixation (Danso 1988). The use of inoculants has allowed the successful introduction of legumes to new farming systems (Giller and Cadisch 1995). Substrate or carrier of the inoculant determines the transfer of the desired *rhizobium* strain with sufficient numbers to targeted legume and also its survival in the inoculant when stored. Peat has been used as the main carrier for legume inoculants for more than 90 years (Brockwell and Bottomley 1995). Little progress has been made with alternative carriers that might enhance the numerical quality of the inoculants. Nevertheless, the search for alternative carrier materials continues particularly in regions with no natural deposits of peat. Amongst polyacrylamide gel (Dommergues et al. 1979), cellulose gel (Jawson et al. 1989) and vegetable oil (Kremer and Peterson 1982) have shown comparable results with peat. However, these synthetic carriers may not be cost-effective in the inoculant production since their production is involved with an initial financial cost. In the present study, a legume inoculant based on coir dust was evaluated in comparison with a peat-based inoculant and mineral fertilizers for nodulation, plant growth and seed yield of soybean in the dry zone of Sri Lanka. The two inoculants were also compared initially for shelf life at the room temperature.

Two separate inoculants based on autoclaved local peat (pH 5.1, water holding capacity, (WHC) 36%, 1.60% total N and 87% organic matter) and autoclaved coir dust (1-2 years old naturally decaying heap; pH 6.3, WHC 523%, 0.37% total N and 96% organic matter) were prepared (Thompson 1980) using *Bradyrhizobium japonicum* strain TAL 102. A part of them were bagged in 10 g packets and were stored in the laboratory at 27-30° C for 25 weeks. Five packets at a time from each inoculant were sampled to enumerate the bacterial cell survival in the inoculants using spread-plate method, after 1, 8 and 25 weeks of the storage (Somasegaran and Hoben 1994).

On-farm trials in farmers' fields were conducted with the two inoculants in Huruluwewa watershed situated in Anuradhapura district of the low country dry zone (DL 1). Soybean crop was inoculated during minor cropping season ("Yala") that extends from April to June. This crop is grown with irrigation in rice-based cropping systems in the watershed. Soil in the watershed is a Rhodustalf with a pH 6.4, 1.1% organic C and 0.096% total N. Five farmers' fields distributed in an area of ca. 125 ha of the watershed were selected as replicates for the study. Four plots of 6x4 m were prepared with ridges of 50 cm apart, in each farmer's field. Four treatments were assigned to the four plots in a Randomized Complete Block (RCB) design; control, farmers' practice (i.e. without mineral fertilizers or inoculant); coir dust-based inoculant; peat-based inoculant; mineral fertilizer recommendation for soybean of the Department of Agriculture, Sri Lanka (urea 23 kg N/ha, triple super phosphate 69 kg P_2O_5/ha and muriate of potash 21 kg K_2O/ha as a basal application and urea 23 kg N/ha as a top dressing at the onset of flowering). The plots were irrigated once every 4-7 days until about 3 weeks before harvest.

Soybean seeds were soaked for 1-2 minutes in a diluted sugar solution and were coated with the inoculants for the inoculated treatments. The crop was seeded at 5 cm spacing on the ridges of the plots, and was maintained according to recommended practices of the Department of Agriculture, Sri Lanka (Crop recommendations technoguide 1990). Leaving an area of 4x3 m in the middle of each plot for the harvest, eighteen plants were removed carefully with soils surrounding the root systems, at flowering.

The soils were removed by soaking in water and nodules were carefully collected. Nodules and the plants were oven-dried at 65°C for 72 hrs and dry weights were recorded. At the maturity of the crop, plants were removed from the harvesting area of each plot and were threshed and seeds were sun-dried. Seed weight was recorded. Data were analyzed using ANOVA and DMRT (SAS 1987). The data on the bacterial cell survival in the two carriers were transformed initially to logarithmic scale ($\log_{10}X$) and analyzed using ANOVA and LSD test.

Initial survival of *B. japonicum* after 1 week of incubation was not significantly different between the two carriers of the inoculants (Fig. 1).

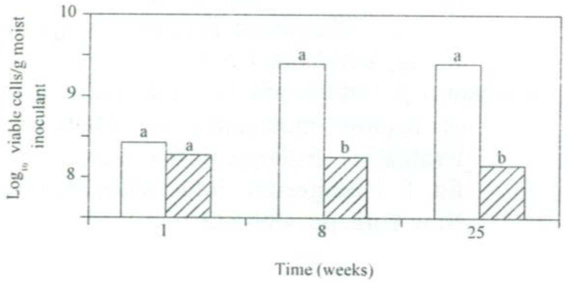

Fig. 1. Survival of *Bradyrhizobium japonicum* TAL 102 in peat (shaded columns) and coir dust based inoculants at 27-30 °C for 25 weeks. Columns with the same letter are not significantly different at 5% probability level, according to LSD test.

However, the survival of the bacterium in coir dust was better than that in peat after 8 weeks. This trend sustained until the end of the incubation period of 25 weeks. Only coir dust maintained the required number of bacterial cells of 10^9 per gram inoculant for quality assurance (Somasegaran and Hoben 1994). Large cell cavities of coir dust particles that conserve required moisture and provide physical protection to the bacterial cells could explain high survival of *B. japonicum* in it, to a great extent (L.H.J. Van Holm, unpublished). Low survival of the bacterium in peat could be attributed to relatively low pH (i.e. 5.1), which has been shown to interfere with its survival (Graham et al. 1994).

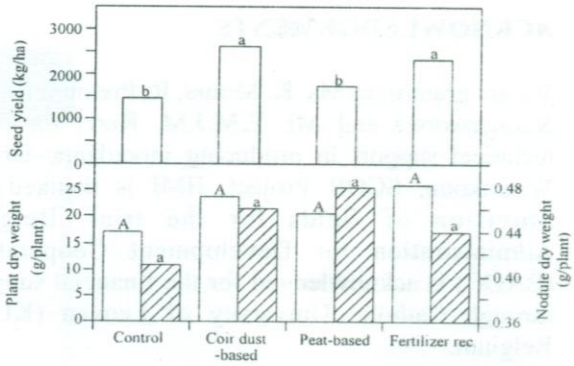

Fig. 2. Nodule (shaded columns) and plant dry weights at flowering and seed yield of soybean under peat and coir dust-based inoculants, mineral fertilizer recommendation (46 kg N/ha, 69 kg P_2O_5/ha, 21 kg K_2O_5/ha) and farmers' practices (control, without mineral fertilizers or inoculants). Columns with the same letter are not significantly different at 5% probability level, according to DMRT .

Nodulation of soybean at flowering did not differ significantly among the inoculants, fertilizer application and farmers' practices (Fig. 2), although the inoculated treatments had numerically high nodule dry weights. Plant dry weight also did not differ significantly among the treatments.

These could be attributed to relatively high coefficients of variation (CV) of the two parameters, which were 44.8% and 35.6% of nodule and plant dry weights, respectively. Coir dust-based inoculant produced the highest seed yield of soybean and it was not significantly different from the yield produced under the fertilizer application. Peat-based inoculant was inferior to coir dust-based inoculant in producing the yield. Yield increases over the farmers' practices of coir dust and peat-based inoculants were 37% and 9%, respectively. It is apparent from these results that being an effective strain, higher survival of *B. japonicum* TAL 102 in coir dust (Fig. 1) has supported to its competitive success with the naturally occurring, relatively ineffective rhizobia in the soil (Brockwell and Bottomley 1995), thus enhancing its nodule occupancy, nitrogen fixation and the seed yield of soybean. Fertilizer application has also supplied the required nutrition for a better yield of the crop.

It is concluded from this study that coir dust is an alternative carrier for rhizobial inoculants, which performs even better than local peat in maintaining numerical quality for improved yields of soybean.

ACKNOWLEDGEMENTS

We are grateful to Ms. K. Moors, R. Premaratne, M. Karagaswewa and Mr. E.M.J.M. Rizvi for their technical support in producing inoculants. Dr. L. Weerakoon, SCOR Project, IIMI is thanked for provision of fields for the trial. Belgian Administration for Development Cooperation (BADC) is acknowledged for the financial support through Catholic University of Leuven (KUL), Belgium.

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