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ABSTRACT

The use of microorganisms capable of promoting plant growth has been accepted as an alternative to reducing the use of chemical fertilizers in chili (*Capsicum annum L.*) cultivation and production. Isolate SA-10 was successfully isolated from rice cultivation soil and showed positive results on nitrogen fixation, potassium solubilization, phosphate solubilization, siderophore production and also cellulose degradation. The highest indole-acetic acid (IAA) also produced by isolate SA-10 with 4.00 (mg/L). Thus, the isolate was chosen to be encapsulated with biochar and sodium alginate as biofertilizer gel beads. The beads consisted alginates and biochar with the size (2-3mm). The beads are made of 2% sodium alginate solution and also biochar and then mixed with liquid bacteria culture. The pot study was done with this encapsulation of bacteria isolated for Chili plant growth enhancement. It was observed that the treated plants showed better growth than the control plants. Plant growth promoting bacteria and encapsulation used, promote the growth of chili cultivation. Objective: 1) to characterize plant growth-promoting bacteria 2) to encapsulate PGPR with sodium alginate and biochar 3) to determine the influence of PGPR using sodium alginate and biochar in chili plant growth.

Keywords: Encapsulation, Biofertilizer, Alginate, Bacteria, *Capsicum annum L*

INTRODUCTION

Encapsulation of plant growth-promoting bacteria is the most efficient technique of making a protective shell or capsule around the microorganism. Sodium alginate is the one that most commonly used product for the encapsulated of microorganism. The mixing of the plant growth-promoting bacteria with biochar and sodium alginate is the best combination that potentially increasing microbial activity and supporting the bacteria survival in the capsule.

METHODOLOGY

Isolation of soil bacteria isolates from rice cultivation area

- 5g soil was collected from rice cultivation area and then the bacteria was isolated on agar media. The plate agar was incubated for 28°C for 24 hrs

Characterization of plant growth promoting bacteria

Six isolated were obtained from rice cultivation area were tested for the following test

- Nitrogen fixation test which followed by (Dobereiner et al., 1976) (figure 1)
- Phosphate solubilizing test which followed method National Botanical Research Institute Phosphate (NBIRP) (figure 2)
- Potassium solubilizing test using followed method from (Aleksandrov et al., 1967)
- Cellulose degrading enzyme production test followed method from (Padaria et al., 2014)
- Siderophore production test followed method from (Schwyn and Neilands et al., 1987)
- IAA production test followed method from (Gordon and Weber et al., 1951)

Encapsulation of biofertilizer

- The bacteria isolates were grown in nutrient broth for 24 hours. 2% sodium alginate solution and biochar and then mixed with 50ml liquid bacteria culture. The solution was drew using syringe into solution of 0.1 M calcium dichloride $CaCl_2$. The beads were washed twice with sterilized tap water and then will let dry for 2-3 hours (figure 3).

Performance of chili plant

- The experiment was designed as a completely randomized design (CRD). The chili crop was grown as a control and encapsulated biofertilizer. The beads were mixed with soil before the plant was transferred into the pot (figure 4)

RESULTS AND DISCUSSION

1. Characterization of PGPR

Isolate SA-10 was successfully isolated from rice cultivation area. The isolate showed positive response towards nitrogen fixation, phosphate solubilization, siderophore production and cellulose degradation. The highest indole-acetic acid (IAA) was produced by isolate SA-10 at 4.00 (mg/L). Thus, SA-10 was chosen to be encapsulated as a potential biofertilizer.

2. Encapsulation of biofertilizer

Isolate was chosen to be encapsulated as a potential of plant growth-promoting bacteria due to its beneficial characteristics. Encapsulation of SA-10 was successful by using biochar and sodium alginate as potential biofertilizer. The encapsulated beads containing SA-10 as biofertilizer can used to the plant. Using the encapsulated biofertilizer, bacteria with alginate to ensure a slow release of nutrients to the soil (Z.Wu et al., 2012). Entrapment of bacteria in alginate can reduce stresses during storage and their progressive release into the soil (Dommergues et al. 1979).

3. Performance of chili plant

The treatment encapsulated bio-fertilizer produced highest of plant height and control treatment produced lower plant height (figure 5). It was observed that encapsulation biofertilizer treatments were superior to the control because using PGPB as a biofertilizer can increase the nutrient availability in the plant crop due to its characteristics. Mixed of sodium alginate and biochar with effective microorganism, potentially increasing microbial activity and supporting the bacteria survival (Ameloot et al., 2015).

Bacteria isolates	Phosphate solubilization ability (%)	Potassium solubilization ability (%)	Nitrogen fixation	Siderophores production	Cellulose degradation	IAA production (mg/L)
SA-10	50.00	76.92	+	+	+	4.007

Table 1. Biochemical characteristics properties of bacteria isolates



Figure 1 formation blue color are presence of nitrogen fixation activity

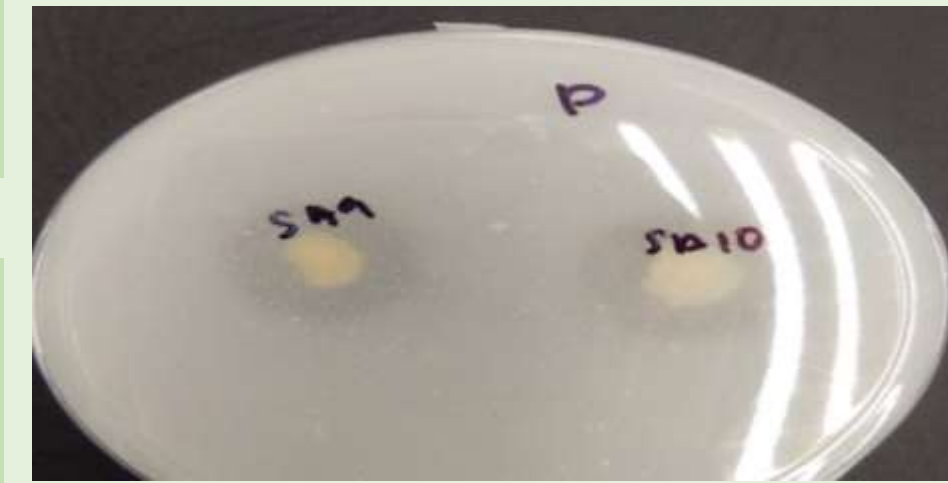


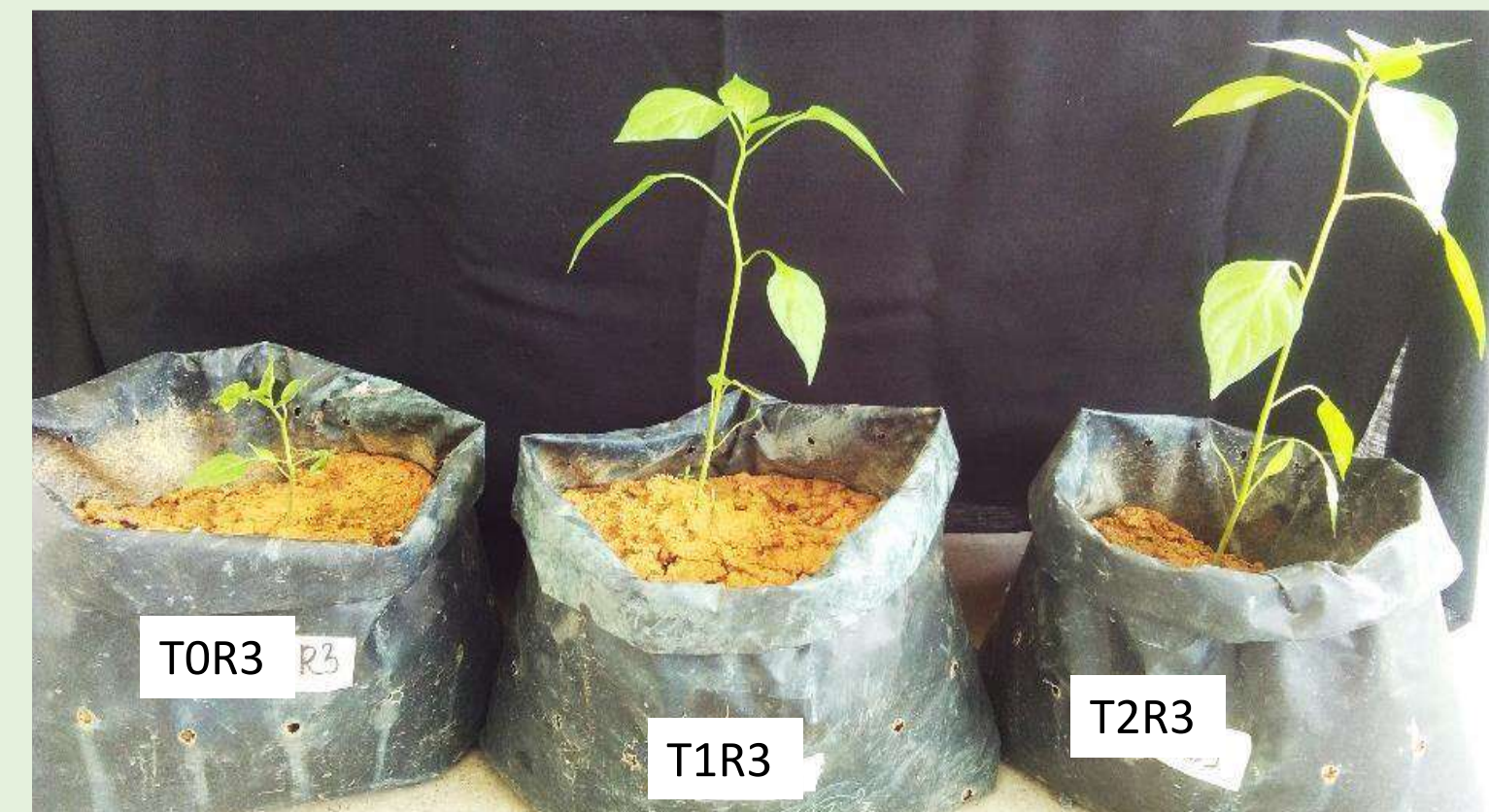
Figure 2 formation of holozones on agar for zinc-solubilizing activity after 48h in incubator



Figure 3 beads were dry for 2-3 hours



Figure 4 the beads were mixed with soil before the plant was transferred into the pot



*T0= Control, T1=non-encapsulated bio-fertilizer, T2= encapsulated bio-fertilizer
Figure 5 Growth performance of chili plant after four week application with different treatment

CONCLUSION

In conclusion,

- Bacteria isolate SA-10 showed highest auxin production.
- Isolate SA-10 was selected to be encapsulated. Encapsulation of SA-10 was successful by using biochar and sodium alginate as potential biofertilizer for performance of chili plant.
- The encapsulated biofertilizer was significantly different from control which had an effect on plant height of chili growth. Thus the encapsulated successfully improved the plant growth performance.

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