Effect of Rhizobacterial Isolates on Sweet potato Plant Growth

FARZANA YASMIN¹, RADZIAH OTHMAN², RASHID MA³, REDDY BN⁴, NAZMUL MHM⁴
¹Faculty of Science, Lincoln University, 12-18, Jalan SS6/12, Off JalanPerbandaran, 47301 Petaling Jaya, Selangor Malaysia
²Faculty of Agriculture, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia.
³Faculty of Medicine, UniversitiTeknologi MARA, Sungai Buloh, 47000 Selangor, Malaysia
⁴Graduate School of Medicine, Perdana University, Jalan MAEPS Perdana, Serdang 43400, Selangor, Malaysia.
Correspondence to Nazmul MHM, Graduate School of Medicine, Perdana University, Jalan MAEPS Perdana, Serdang 43400, Selangor, Malaysia. Email: poorpku@yahoo.com

ABSTRACT

Aim: Plant growth promoting rhizobacteria (PGPR) are beneficial bacteria that improve plant growth by a wide variety of mechanisms. This study was conducted to observe the effect of Rhizobacterial isolates on early growth of sweet potato plants.

Methods: A pot experiment under glasshouse conditions was conducted to observe early growth of plants as affected by bacteria. The inoculation process could stimulate the plant growth and development as observed in the smaller pots (2kg soil). Plants were treated with PGPR isolates and harvested after 30 days of growth.

Results: Four bacterial isolates produced PGP compounds like IAA, solubilized phosphate, fixed nitrogen and resistance to antibiotic. Most of isolates resulted in a significant increase of root and shoot growth. A significant increase of root volume (58%) and root dry weight (56%) was recorded as compared to uninoculated control. The results showed that inoculation of Klebsiella sp. UPMSp9 and Erwinia sp. UPMSp10 increased tops and roots growth, uptake of N, P, K Ca and Mg in plant tissue and bacterial population in soil.

Conclusion: The experiment indicated that Klebsiella sp and Erwiniasp. used as bioenhancers might be beneficial for growth of sweetpotato.

Key words: Sweet potato, Plant growth-promoting rhizobacteria, Klebsiella sp and Erwiniasp.

INTRODUCTION

Sweet potato is an important starchy root crop growththroughout the tropical and sub-tropical countries. It is a very nutritive vegetable, producing substantially high energy per hectare per day compared to rice, wheat, maize and cassava. Sweet potato requires high input of chemical fertilizers for commercial production. Chemical fertilizers can reduce the soil microbial flora and fauna which also cause environmental pollution, water pollution, health problems as well as increase the cost of production (Umair et al., 2018). Plant growth-promoting Rhizobacteria (PGPR) are a group of bacteria that colonize the rhizosphere and provide direct or indirect effect of the crop plants. It has been found that PGPR significantlyenhanced plant and root growth and plant nutrition as well as yield of many crops (COMPANT and Sessitsch, 2010 and Ashok et al., 2015). PGPR shows promising results by making nutrients more available (e.g. by solubilization of phosphates) or increasing plant access to nutrients (e.g. by increasing root surface area). PGPR strains were observed to enhance the uptake of nutrient and yield in corn, wheat, sorghum and rice plants which are the major contributors for beneficial effects of PGPR to plants. (Ashrafuzzaman et al., 2009 and Das et al., 2013).

Dawwam et al., (2013) isolated different PGPR strains from sweetpotato roots. Seven Rhizobacterial (PGPR) strains were tested for IAA producing and Phosphate Solubilizing activity. All isolates were able to produce IAA while four isolates solubilized rock phosphate. These isolates increased nutrient uptake as well as increased shoot and root dry weights. Plant growth improvement by PGPR could be due to mechanisms such as the ability to produce hormones like indole acetic acid, gibberellic acid and cytokinins, asymbiotic nitrogen fixation, antagonism against phytopathogenic microorganisms and solubilization of mineral phosphates and mineralization of other nutrients(Bashan et al., 2014). Therefore, an experiment was conducted to observe the effect of Rhizobacterial isolates on early growth of sweetpotato plants.

MATERIALS AND METHODS

Vine cuttings of sweet potato was grown in two kg of sterilised sandy soil. The bacterial treatments consisted of: i) Control, ii) Klebsiella sp. UPMSp9 iii) Erwinia sp. UPMSp10 iv) Azospirillum sp.SP7 and v) Bacillus sp.UPMB10. An inoculum concentration of 10⁷cfu/ml was applied into the respective pots. Each pot was inoculated at planting and two weeks after planting with five ml inoculum/pot/application. The pots were covered with black polythene bag to prevent direct contamination. Hoagland solution (Hoagland, 1950) was then added into each pot every two days to supply plants with the essential plant nutrients. All plants were watered daily with distilled water as required. The experiment was run in a Completely Randomized Design (CRD) with three replications. Plants were harvested at 30 days of growth.

At the harvest time sweetpotato shoots (leaves and stems) were separated from the whole roots and soil and their fresh weights were determined. The shoots were placed into brown paper bags and oven dried at 70°C for two days and the dry weights were recorded. Fibrous roots and storage roots were separated from the soil, washed and cleaned from adhering soil and their fresh and dry weights were determined. Fresh soil was sampled for total bacterial population and the rest was air dried for nutrient content analysis. Root volume was determined by using the water displacement method.

1025  P J M H S  Vol. 14, NO. 2, APR – JUN 2020
Dried shoots were ground using electric grinder and passed through 0.5 mm sieve. Shoot samples were digested with concentrated sulphuric acid (H2SO4) and hydrogen peroxide (H2O2) following the micro-kjeldahl method (Thomas et al., 1967). N, P, K concentrations were determined by using autoanalyser and Ca, Mg by using Atomic Absorption Spectrophotometer. The total population of bacteria in soil was determined at harvest by using total plate count technique (Parkinson et al., 1971). The concentrations of IAA in soil were measured using modified method of Sarwar et al., (1992). Soil pH was measured with a glass electrode pH meter (PHM 210, Metrolab) in a 1:2.5 soil-water suspension. The total nitrogen concentration was determined following the micro-Kjeldahl method (Bremner, 1982). The available phosphorus was measured by Bray-2 method (Bray and Kurtz, 1945). Concentrations of exchangeable K, Ca and Mg were determined using the shaking method (Schollenberger and Simon, 1945).

Statistical Analysis: Analysis of Variance (ANOVA) were run using Statistical Analysis System (SAS, version 6.12, 1989), and treatments means were compared using Tukey Studentized Range (HSD) test at p=0.05.

RESULTS AND DISCUSSION

Plant growth: Significant difference in the plant growth were observed between the bacterial strains tested (Table 1). Plants treated with Klebsiella sp. UPMS9 and Erwinia sp. UPMS9P10 showed significantly higher shoot and root dry weights and root volume compared to uninoculated control. These could be due to the ability of the bacteria to produce IAA (auxin) and other plant growth regulators activities. The IAA would promote root initiation, cell division and cell enlargement, which stimulated growth and development of roots and morphological and physiological changes in inoculated plant roots (Rathaur et al., 2012 and Ashraf et al., 2011). Previous studies showed that the use of indole acetic acid (IAA) producing PGPR significantly increase in plant height, root length and dry matter production of shoot and root of rice seedlings(Ashrafuzzamanet et al., 2009).Rani et al.(2012) isolated sixty Rhizobacteria which produced indole acetic acid (IAA) and other PGPR traits. PGPR isolates influenced seed germination, shoot length, root length, dry matter production of shoot, nodule number and nodule mass of pigeon pea.

Nutrient Uptake in Shoot: Inoculation with rhizobacteria significantly (p≤0.05) increased the nutrient uptake in sweetpotato shoots (Table 2). Plants inoculated with Klebsiella sp. UPMS9P9 and Erwinia sp. UPMS9P10 seemed to show higher uptake of N, P, K, Ca and Mg compared to the uninoculated control. Improved plant growth with inoculation was due to increased uptake of N, P, and K of the plants. The enhanced uptake of essential nutrient could be due to stimulation of root growth and development of the plants which subsequently increased dry matter and accumulation of minerals in stems and leaves (Gravelet et al., 2007 and Kumar et al., 2014). The beneficial effect of bacterial inoculation on sweet potato has been observed by Radziah and Tan (1999) and Farzana et al. (2008). They observed more plant growth and nutrient uptake in inoculated sweet potato plants compared to uninoculated plants. Biostimulant species of Pseudomonas and Bacillus can produce phytohormones or growth regulators that cause crops to have greater amounts of fine roots which have the effect of increasing the absorptive surface of plant roots for uptake of water and nutrients(Sharma et al., 2012).

Population of Bacteria and Nutrient Concentrations in Soil: The PGPR inoculation significantly (p≤0.05) influenced bacterial population, N, P, Ca, and IAA concentration in the soil.(Table 3 and Table 4). Soil inoculated with Klebsiella sp. UPMS9P9 showed the highest total bacterial populations, soil pH, Mg and IAA concentrations. Higher nutrients concentrations may also be due to the supplied nutrient solution (Hoagland solution). Other studies have shown that single or dual inoculation of wheat seedlings with PGPR in sterilized soil resulted in significantly increased nutrient contents in soil (Dinesh R and Ghoshal Chaudhuri S, 2013). Higher IAA concentrations in the soil probably due to the bacteria synthesized IAA through TRP pathways (Dinesh et al., 2010, Kumar et al., 2015). However, there was presence of bacteria in the uninoculated control soil even though the soil used was sterilized. This could be due to the contamination from the dust in the glasshouse. Higher population of total bacteria was observed in soil inoculated with Klebsiella sp. UPMS9P9 and Erwinia sp. UPMS9P10. These bacteria could positively interact with plants roots and enhance plant growth. Compounds presented in root system of sweet potato plant would affect the composition and activity of microbial population in the rhizosphere. Plants growth influence microbial population by the secreting plant exudates, which consist of several organic compounds such as sugars, amino acids, vitamins, tannins, alkaloids, phosphatides and other unidentified substances (Dinesh et al., 2012and Xingel et al., 2014). The simple sugars could provide readily available sources of carbon and energy for microbial growth that encouraged proliferation of other indigenous rhizobacteria.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Shoot Dry Weight(g Plant−1)</th>
<th>Root Dry Weight(g Plant−1)</th>
<th>Root Volume(cm3)</th>
<th>Shoot to Root Ratio(S/R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klebsiella sp.</td>
<td>7.54a</td>
<td>2.45a</td>
<td>17.74a</td>
<td>3.04ab</td>
</tr>
<tr>
<td>Erwinia sp.</td>
<td>6.94ab</td>
<td>2.38b</td>
<td>16.74ab</td>
<td>3.14b</td>
</tr>
<tr>
<td>Bacillus sp.</td>
<td>5.69ac</td>
<td>2.16c</td>
<td>16.15bc</td>
<td>2.61b</td>
</tr>
<tr>
<td>Azosporillum</td>
<td>6.16bc</td>
<td>2.16c</td>
<td>13.73bc</td>
<td>2.90bc</td>
</tr>
<tr>
<td>Control</td>
<td>5.50c</td>
<td>1.59c</td>
<td>11.21c</td>
<td>3.45c</td>
</tr>
</tbody>
</table>

Note: Means followed with same letter (s) in column are not significantly different (P>0.05)
CONCLUSION

In conclusion, our result suggested that PGPR inoculation significantly increased the early growth of the sweetpotato plants under pot experiment. PGPR are highly beneficial for plant growth and can serve as potential bioenhancers. Plants inoculated with *Klebsiella* sp. UPMS9 and *Erwinia* sp. UPMS10 increased growth (tops and roots) and nutrient uptake (N, P, K, Ca and Mg) of the sweetpotato plants. Improved plant growth was related to the improved soil chemical and microbial properties.

REFERENCES


