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Commercial Potential of Plant Growth Promoting Rhizobacteria on Amaranthus Hybridus in Ede, Osun State, Nigeria

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ABSTRACT

The eco- friendly improvement of crop yield is a mammoth task that must be tackled in order to meet the ever increasing world population in need of food. Increment in food yield and reduction of the negative impact of agricultural practices are major goals to be achieved by farmers in recent times. Plant growth promoting rhizobacteria (PGPR) are organisms known to increase the growth of plants, by directly or indirectly facilitating crop yield by a number of mechanisms, from simple ion exchange, atmospheric Nitrogen fixation, solubilization of insoluble phosphates, secretion of hormones such as IAA, GAS, and Kinetins, and Induced systemic resistance. Vegetables are stable foods rich in numerous vitamins. Low income countries get a balance diet through regular consumption of vegetables. Vegetables like *Amaranthus hybridus* is consumed regularly with highly starchy food across the Southern states of Nigeria. The use of fertilizer to plant this vegetable over the years has led to a reduction in the crop yield. This study investigated the effect of different bacterial suspension samples in increasing the growth parameters of *Amaranthus hybridus.* Bacterization by microorganisms tagged ADK 1, ADK 2, ADK3, ADK4, ADK 5, ADK 6 and ADK 7. The pot trial showed an increase in the growth yield of Plant affected by ADK 5 and ADK 7. A synergistic effect of ADK 5 and ADK 7 did not give an increased yield as each individual effect. Investigations into the bacterization of indigenous vegetables by indigenously isolated bacteria is an eco-friendly agricultural practice to be promoted.

Keywords: *Amaranthus hybridus*, bacterization, PGPR, Ede, Osun State, Nigeria

Aims Research Journal Reference Format:
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1. INTRODUCTION

There is an ever increasing demand to feed the ever increasing world population which has been estimated to be 9 billion by 2050 (Vejan *et al*., 2016). To feed this teeming population, Crop productivity must increase between 70 - 100%. The task of providing food for these people will be most severely challenging to developing countries, whose populations are expected to grow to 7.9 billion [UNFPA, 2013]. Industrialized systems of Agriculture involves the use of agrochemicals which leads to an increase in the production of crops. This however comes with some ills which have raised concerns bordering upon health including the presence of toxic substances in drinking water, occupational exposure and poisoning (Suyal *et al.,* 2016). Certain plant growth promoting rhizoobacteria (PGPR) improve crop yield either directly or indirectly.

Direct mechanisms by PGPR, include the provision of bio-available phosphorus for plant uptake, nitrogen fixation for plant use, sequestration of iron for plant by siderophores, production of plant hormones like auxins, cytokinins and gibberellins and lowering plant ethylene levels using ACC deaminase that accumulate during biotic and abiotic stresses (Glick *et al*., 2014). Indirect mechanisms of PGPR include production of antibiotics, viz. 2,4 Diacetyl phloroglucinol (DAPG), phenazine, pyoluteorin and pyrrolnitrin against pathogenic fungi and bacteria, reduction of iron available to phytopathogens in the rhizosphere, synthesis of fungal cell wall and insect-gut membrane lysing enzymes, chitinase enzyme for hydrolysis of chitin layer of the eggshell of nematode and also competition with detrimental microorganisms for sites on plant roots and induction of systemic resistance against various pathogens and pests in plants (Ramamoorthy *et al*., 2013).

In the recent years, the PGPR have received worldwide importance for agricultural benefits as they are the potential tools for sustainable agriculture and have shown significant increases in growth and yield of agricultural crops both under greenhouse and field conditions. There is now an increasing number of PGPR being commercialized for application to crops (Quan *et al*., 2011). Due to the multiple beneficial effects of PGPR which includes: plant growth, soil fertility, eco-friendly nature, and low-cost effectiveness, it certainly helps in improving profitability and livelihoods of small and marginal farmers in Ede. Application of PGPR without or with low fertilizer rates could be a viable supplementary strategy for maximum benefits in terms of cost of production and sustaining productivity (Abbasi *et al*., 2011).

Several elements are needed for the proper growth of plants. Element including Nitrogen, Phosphorous and Potassium make up common fertilizers. Phosphorus (P) is one of the key macronutrients required for growth and development of plants. (Midekssa *et al*., 2016). Seed or root bacterization usually means treatment of seeds or seedling roots with cultures of bacteria that will improve plant growth; such preparations are frequently called bacterial fertilizers (Brown., 2014). Seed bacterization with these organisms has emerged as a powerful technology to enhance plant growth and yield, besides providing protection against disease. Vegetables are the cheapest and most available sources of important proteins, minerals, vitamins, and essential amino protein. These vegetables are commonly consumed and used in Africa for the treatment of illness (Adewale and Olorunju, 2013). *A. hybridus* are popular vegetables in West Africa and have been reported to possess many antioxidant components and other medicinal values (Maiyo *et al*., 2010). Many farmers in Ede, Osun State, Nigeria are known to plant *Amaranthus hybridus* often. The locals call it '*Efo Tete*'. Fertilizers are always used to improve the plant yield of this vegetables by local farmers. This study seeks to explore and determine indigenous bacteria with plant growth promoting traits, which will serve as a better and eco-friendly way of improving the yield of *Amaranthus hybridus*.

2. MATERIALS AND METHODS

The experiment was carried out between November 2018 and December 2018 at the Department of Microbiology, Adeleke University Laboratory. Seeds of *Amaranthus hybridus* were purchased from Ede Market where local farmers purchase seeds for planting and transported aseptically to the Microbiology Laboratory of Adeleke University, Ede, Osun State.

Soil Sample Collection

Rhizosphere soil samples were collected from different areas in, Ede South (7°42'N, 4° 27'E), Osun State. Soil samples were collected at a depth of 0 – 6inches using a soil sampler. 9 samples were collected from different sites. Samples were collected in aseptic containers and immediately transported to laboratory under cold condition using ice packs in a cooler.

Isolation of Rhizobacteria

Bacteria were isolated from the rhizosphere soil samples by serial dilution technique on nutrient agar (NA) plates and incubated at 28^{0}C for 72 hrs. After incubation, NA plates were observed for morphological appearances and number of bacterial colonies. Bacterial isolates having different morphological appearance on agar plates were selected, pure cultures were obtained and maintained on nutrient agar slants.

Identification of Bacterial Isolates

Identification and Characterization*:*

The bacterial isolates were characterized by their cultural conditions, morphological and biochemical characteristics using standard methods and sent for molecular identification:

Morphological Characterization

All the 118 isolates upon purification through successive sub-culturing were studied for colony morphology and pigmentation. The cell shape and Gram reaction were also recorded as per the standard procedures given by Barthalomew and Mittewar (1950).

Isolation and Screening of PGPR Isolates

Isolates were screened for plant growth promoting traits by a number of tests including viz: Phosphate solubilization test, Production of Ammonia (Cappuccino and Sherman,1992), Analysis of phosphate solubilizing activity of isolates, Quantitative assay of Indole Acetic Acid (Rahman *et al*., 2010), and Hydrogen cyanide production (Castric, 1975).

3. RESULTS AND DISCUSSION

A total of one hundred and eighteen morphologically distinct microbes where isolated from the soil samples of plants in farms in Ede, Osun State. The percentage population of the isolates are shown in figure 1.0, The highest percentage distribution is ADK 5 with 45% and the least percentage is ADK3, ADK4, ADK6 and ADK 8 respectively with 5%.

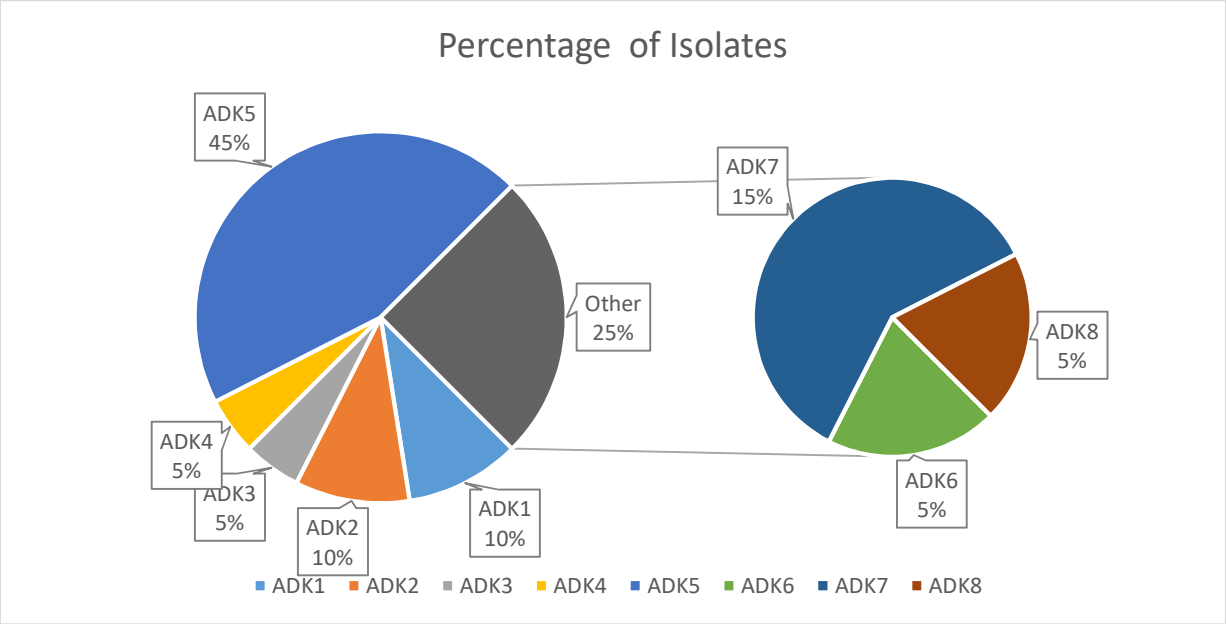

Figure 1: Percentage Distribution of Isolates

Bacterial strains were isolated from the rhizosphere of plants from farm lands in Ede using standard microbiological standard technique. The 118 isolates were screened for Plant growth promoting traits which include: Phosphate solubilization test, Production of Ammonia, Analysis of phosphate solubilizing activity of isolates, Quantitive assay of Indole Acetic Acid Production, and Hydrogen cyanide production. A total number of 18 isolates were positive to the tests, out of which ADK5 and ADK 7 performed the best as evidenced in the quantitative analysis of phosphate solubilizing bacteria at 530nm in Figure 2.

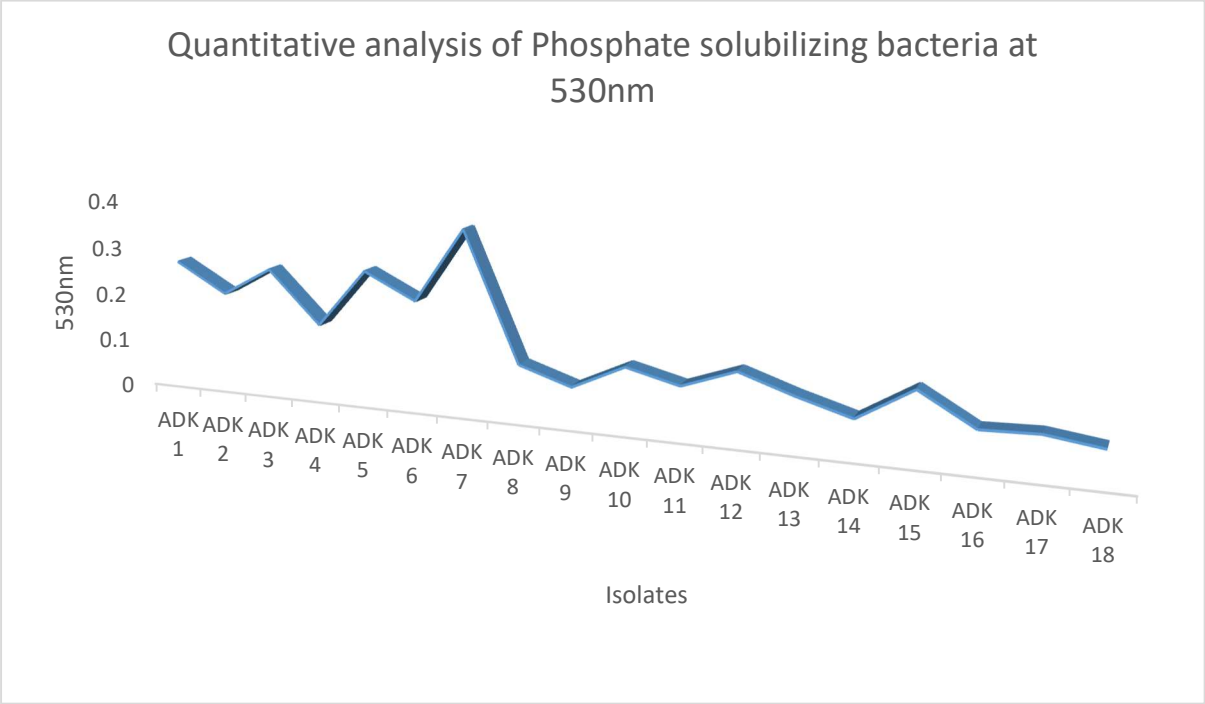

Figure 2: Quantitative analysis of Phosphate Solubilizing bacteria at 530nm

Bacterized seeds of *Amaranthus hybridus* with different organisms is shown in figure 3. Bacterial suspension of ADK 5 and ADK 7, perfomed best in terms of germination of seeds after a duration of 24hrs.
Isolates were grown in LB broth supplemented with 5 mM Ltryptophan for 48 h and their IAA producing ability was detected according to method described by Bric et al. (1991).

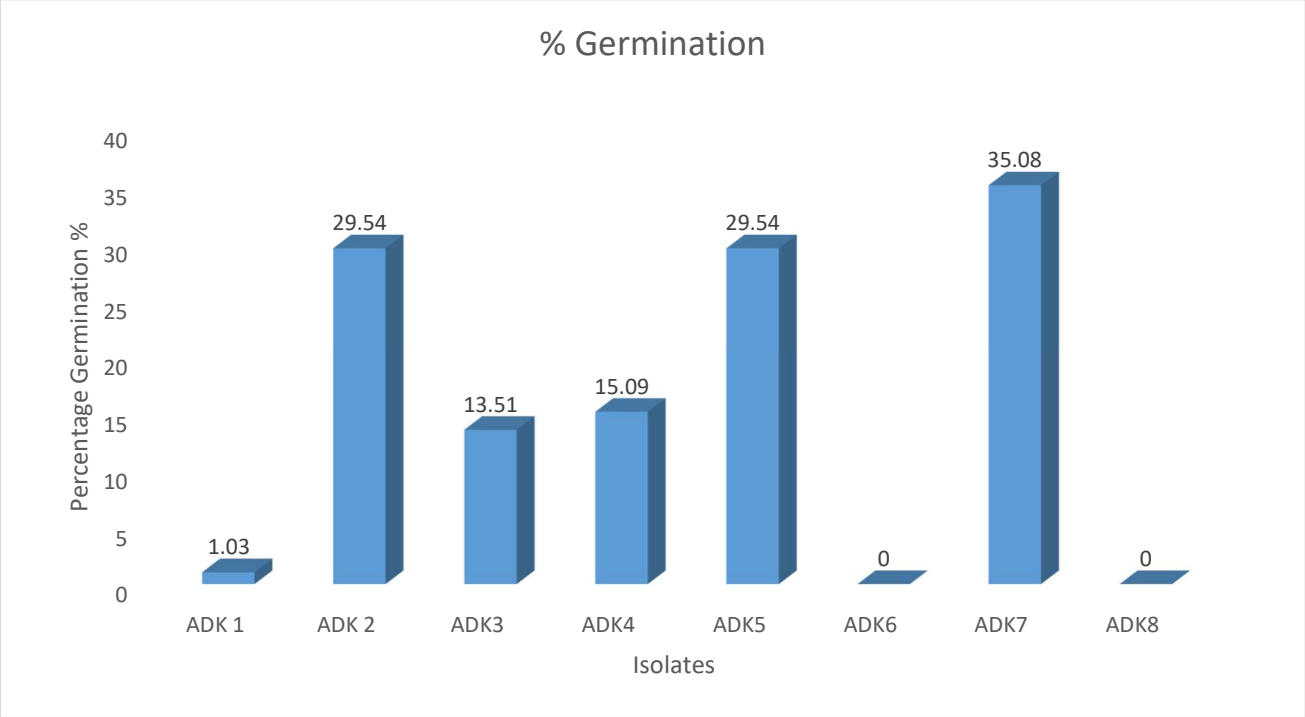

Figure 3: Percentage Germination of *Amaranthus hybridus* as bacterized by different isolates

In the present study eight (8) bacterial isolates were positive for IAA, Ammonia production which are important traits of PGPR. The eight selected bacterial isolates were also able to produce catalase which is in accordance with the work of Kumar et al (2012). The percentage germination was significantly increased after seed bacterization. This study is serves as a baseline for others.

The search and use of indigenous plant growth promoting rhizobacteria will be the basis for future ecofriendly crop improvement practice. The associated problems that comes with the use of fertilizers would be reduced and/or eradicated with the use of PGPR. Studies to determine PGPR best suitable for production of crops at an economical level is a study that must be embarked upon.

4. CONCLUSION

The use of fertilizer to plant this vegetable over the years has led to a reduction in the crop yield. This study investigated the effect of different bacterial suspension samples in increasing the growth parameters of *Amaranthus hybridus.* Bacterization by microorganisms tagged ADK 1, ADK 2, ADK3, ADK4, ADK 5, ADK 6 and ADK 7. The pot trial showed an increase in the growth yield of Plant affected by ADK 5 and ADK 7. A synergistic effect of ADK 5 and ADK 7 did not give an increased yield as each individual effect. Investigations into the bacterization of indigenous vegetables by indigenously isolated bacteria is an eco-friendly agricultural practice to be promoted.

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