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Effect of Liquid Formulation of *Azotobacter* and PSB Inoculation on Soil Biological Properties

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ABSTRACT

The present investigation entitled "Effect of liquid formulation of Azotobacter and PSB inoculation on growth and yield of lettuce (Lactuca sativa L.)" was carried out at Department of Plant Pathology, College of Agriculture, Punein viewto study the population dynamics of Azotobacterand PSB at periodic interval, their effect on growth parameters and nitrogen uptake by lettuce crop. There were seven treatments, including seed treatment with liquid Azotobacterand liquid PSB @ 25 ml/kg of seed; Foliar spray of liquid Azotobacterand PSB @ 25ml/lit, in alone and in combination; respectively. Results revealed significantly improved crop growth and better soil biochemical properties over uninoculated control. The higher seed germination per cent (84.44%) recorded in seed treated with liquid Azotobacter + PSB.It also revealed beneficial effects on biological properties. There was found highest Azotobacter and PSB population at growth stage while decreased at harvesting stage. Considering all these parameters, it could be concluded that liquid Azotobacter and PSB improved soil biochemical properties which may ultimately influence the growth of lettuce.

Key words: *Azotobacter, PSB, Population.*

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is an annual plant belong to family asteraceae. It is most often grown as a leafy vegetable, but sometimes for its stem and seeds. Lettuce is most often used in salads, also in other kinds of food, such as soups, sandwiches. Lettuce is a good source of vitamin A and potassium, as well as a minor source for several other vitamins and nutrients.

Liquid biofertilizer technology is an alternative solution to carrier based biofertilizers. It comprises aids to preserving organism, to delivering them to their targets and improves their activities. These are special liquid formulation containing not only the desired microorganism and their nutrients but also special cell protectants or substances that encourage formation of resting spores or cyst for longer shelf life and tolerance to adverse condition.

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Unlike the lignite based biofertilizers, liquid biofertilizers have a longer shelf life (Rao, 2007). By applying an appropriate liquid biofertilizer, the overall cost of production will be much lower as compared to traditional chemical fertilizers (Chin, 2010).

Azotobacter is commonly found in rhizosphere and phyllosphere of plants and is very effective for the improvement of soil fertility and crop productivity. It can fix nitrogen directly from the atmosphere that helps plants for better grain production. Besides, nitrogen fixation, *Azotobacter* also produces growth hormones *viz;* thiamine, riboflavin, nicotine, indole acetic acid and gibberellins. Seed or soil inoculation with phosphate-solubilizing bacteria is known to improve solubilization of fixed soil phosphorus and applied phosphates resulting in improvement of plant growth performance and higher crop yield. Application of phosphorus along with phosphate solubilizing bacteria (PSB) improve P uptake by plants and yield indicating that the PSB are able to solubilize phosphates and to mobilize phosphorus in crop plants. Bio-fertilization with PSB could provide a better alternative for the extensive use of phosphate fertilizer in crop production (Rogers *et al.* 1993).

An application of biofertilizer to seeds improve its germination to a considerable extent and controls plant diseases infection due to antagonistic nature considering the adverse effect of chemical fertilizers, the bio-fertilizers are economically cheaper and work as eco-friendly. In view of this background information, the present experiment was undertaken to study the population dynamics of *Azotobacter*and PSB at periodic interval,their effect on growth parameters and nitrogen uptake by lettuce crop.

MATERIAL AND METHODS

Seed inoculation

For inoculation of liquid *Azotobacter*, the seeds of lettuce were dipped in liquid *Azotobacter* suspension @ 25ml/kg of seeds and seed treatment with liquid PSB was given by dipping seeds in liquid PSB suspension @25 ml/kg.

Seed germination

The germination count was taken at 10th DAS and germination percentage was calculated for all the experimental pots by following formula:

$$\text{Germination Percentage} = \frac{\text{Total number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Collection of Soil Samples for microbial analysis:

The microbial count for total *Azotobacter* and PSB population inrhizospheric soil samples were recorded before sowing, 30 DAS and at maturity stage of plant growth using serial dilution pour plate technique (Subba Rao, 1999). The total *Azotobacter* population was enumerated on Jensen‟s medium at 10-5 dilutions. The plates were labelled properly and incubated at 28±20C temperature for 72 hours and colonies were counted. The total PSB population count was taken by transfer one millilitre from each of the soil sample into sterile Pikovaskia‟s media at 10^{-5} dilution aseptically and incubated at 280C (± 20C) temperature for two to three days. The total *Azotobacter* and PSB population in one gram soil was calculated by following formula:

$$\text{No. of bacteria per gram of soil} = \frac{\text{Av. Plate colony count}}{\text{Oven dry weight of sample}} \times \text{dilution factor}$$

RESULTS AND DISCUSSION

Effect on seed germination

The results on seed germination shown statistically non-significant over uninoculated control. However, marginal increase in seed germination in seed treatment with liquid *Azotobacter* @ 25ml/kg + seed treatment with liquid PSB @ 25ml/kg (84.44%) than uninoculated control (75.55%). The increase in germination percentage due to inoculation of liquid bioinoculants may be due to ability to suppress the growth of antagonists present in soil and on seed coat and release of plant growth promoting substances around seed rhizosphere. Similar observations were also noted by Jadhav and Patil (1985) reported that *Azotobacter* as biofertilizer performed better than inorganic fertilizers in relation to seed germination of paddy plant and Sajindranath *et al.* (2002) in okra due to biofertilizers like *Azotobacer* and PSB. Sharma *et al.* (2007) found that increase in seed germination due to inoculation with PSB in *Cicer arientinum* L. The bioinoculants *Azotobacter* and PSB found the significant increase in seed germination percentage was reported by Pathak *et al.* (2013). Similar findings by Mahato *et al.* (2009) with *Azotobacter* as a biofertilizer.

Soil *Azotobacter* population

The *Azotobacter* population was higher at vegetative growth stage and decreased at maturity stage. The significantly higher count (23.33×10^{-5} g^{-1} of soil) was recorded due to application of seed treatment with liquid *Azotobacter*@ 25 ml/kg + foliar spray of liquid *Azotobacter*@ 25 ml/lit and lowest (11.00×10^{-5} $g^{-1}$of soil) in uninoculated control. Increase in *Azotobacter* population following seed inoculation has been reported by several workers. This has reflected in significant increase growth parameters of lettuce as compared to uninoculated control. Toukhy and Jana (2000) reported application of inorganic nitrogen and biofertilizer significantly increased the microbial activity of rhizosphere of barley and also increase total microbial count and Borollosy *et al.* (2001) in sorghum rhizosphere.

Soil phosphorus solubilising bacteria (PSB) population

The increasing trend of PSB population in soil due to inoculation with liquid bioinoculants was observed up to 30 DAS i.e. vegetative growth stage and decrease at 60 DAS i.e. harvest stage. The significantly maximum PSB population (19.67×10^{-5} $g^{-1}$of soil) was recorded due to application of seed treatment with liquid PSB @ 25 ml/kg, over uninoculated control (5.67×10^{-5} $g^{-1}$of soil). The more organic root exudates are being secreted by plants during its growth period as compared to harvest stage which enhance the microbial population around rhizosphere. Increase in PSB population following seed inoculation has been reported by several workers. Kim *et al.* (1998) showed interaction of vesicular arbuscularmycorrhizae and PSB significantly increase plant growth and soil microbial activities leads to increased microbial population. Sundara *et al*. (2002) found that PSB application leads to increase the PSB population in the rhizosphere and increase the plant available P status in the soil, over control. Shinde and Latake (2009) revealed that phosphate solubilizing bacteria *B. megaterium* was significantly superior and synergistic leading to improved bacterial population in soil at various stages in the soil as compared to single culture inoculation on pearl millet. Kundu *et al.* (2009) found that variation in the PSB count during the different growth stages of some selected crops as chickpea, mustard and wheat and found the large variation ($3\text{-}67 \times 10^{-5}$ g^{-1}) and the decreasing count at their maturity period. Kravchenko *et al.* (2013) found differential microbial count in soil during different growth stages of soybean and its impact on increase in yield.

SUMMARY AND CONCLUSION

Effect of inoculation with liquid *Azotobacter* and PSB inoculants on the growth of lettuce plants revealed that seed treatment with foliar spray of bioinoculants was superior for soil *Azotobacter* population (23.33×10^{-5} $g^{-1}$of soil) and soil PSB population (19.67×10^{-5} $g^{-1}$of soil), over uninoculated control.

Thus, the above studies indicate that the liquid *Azotobacter* and liquid PSB were shows positive effect in respect of biochemical properties of soil, which ultimately influence the growth and yield of crop.

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