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APPLIED USE OF AZOTOBACTER IN AGRICULTURAL CROP PRODUCTION

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Abstract

Injudicious use of inorganic chemical fertilizers leads to the imbalance of nutrients in soil causing ill effect on soil physical and chemical health and micro flora. Therefore, in order to decrease the consumption of these energy intensive hazardous inorganic fertilizers, there is an urgent need to encourage the use of the organic and biofertilizers. Azotobacter is an important nitrogen fixing microorganism which has beneficial effects owing to their nitrogen fixing efficiency and their ability to produce anti-bacterial and anti-fungal components. These can play a key role in conservation of environment and soil sustainability.

Introduction

Biofertilizers not only maintain soil health and higher productivity but also provide greater stability to the crop production. Biofertilizers are the microorganism containing carrier based products which are used to improve soil, seed and plant health. The microorganisms are of two types either free living or symbiotic with plants which fix atmospheric nitrogen. Biofertilizers are the non-bulky, ecofriendly and cheaper sources of nutrients widely used in farming and having capacity to increase 10-40% yield in oilseeds, food crops and vegetable crops. Application of these microorganisms help in improving the biological activities of targeted microorganisms in soil and also help in plant growth, fruit yield, seed yield and quality. Amongst biofertilizers, Azotobacter is an important nitrogen fixing microorganism which has beneficial effects owing to their nitrogen fixing efficiency and their ability to produce anti-bacterial and anti-fungal components (Pandey and Kumar 1989; Pandey *et al*., 1998). The most common species of azotobacter is *Azotobacter chrococcum* which *largely* used for nitrogen fixation in agricultural crops (Becking, 2006; Martyniuk and Martyniuk, 2003). Azotobacteria are mostly present in the rhizosphere of plants and also depends on the crop species.

Methods of Application

i. **Seed treatment**

Azotobacter inoculated seeds induce the uptake of macro and micronutrients in crops. Inoculated seeds help in increasing the yield and quality of produce by supplying nitrogen to the crops. Seeds are treated with azotobacter prior to sowing. For treatments culture of biofertilizers mixed and prepare a paste in little amount of water. Paste can be prepared by adding small amount of jiggery in water that helps better texture. After that seeds of particular crop should be mixed well with mixture of azotobacter until it get well mix-up. A layer will be formed when it uniformly distributed in the seeds.

ii. **Soil treatment:**

In this methodology the culture of biofertilizer should be mixed with the soil or farmyard manure in the ratio of 1:50. The mixture of both should distribute uniformly into soil or field.

iii. **Seedlings treatment**

Seedlings of different plant species can be treated with this biofertilizer. In this method culture of azotobacter mixed in 5litre of water. Each packet contains around 200g of weight. The liquid material poured in a pain so that plant can easily get dip. Roots of seedlings should be dipped in the liquid mixture for 15-20 minutes followed by transplanting.

Crops and Applications

Azotobacter is a N_2 fixing free living biofertilizer which is suitable for all type of crops like cereals, vegetables, fruits, plantation and other horticultural crops. Recently, it gained popularity worldwide in vegetables crops like cabbage, broccoli, cowpea, eggplant, tomato etc.

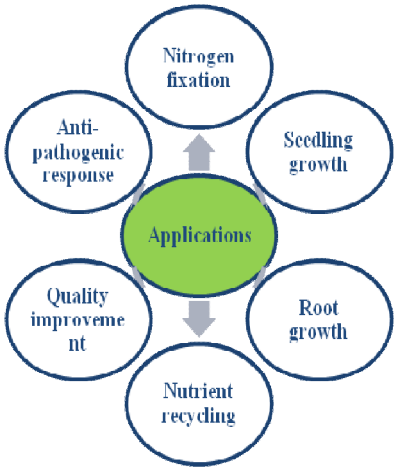
Table 1: Recommendation of treatment methods for different crops

Crops	Method of application
Cereal crops: wheat, barley, finger-millets etc	Seed treatment
Oilseeds: mustard, linseeds, castor etc.	Seed treatment
Fruit crops	Soil treatment
Vegetable crops	Soil treatment/ seedling treatment
Nuts	Soil treatments /seedling treatment
Plantation crops	Soil treatment /seedling treatment
Grasses	Seed treatment

Fig.1: Major applications of Azotobacter in agriculture

Major Applications and Advantages

Azotobacter has the ability to produce vitamins like thiamine and riboflavin and plant hormones viz., IAA, GA like substances and cytokinins. These plant growth promoting substance are exogenously released by Azotobacter and thus the growth and productivity of the plant is improved.



Seed germination:

Azotobacter enhances seed germination in many cereals and horticultural plants. It has beneficiary response on crop growth rate (CGR). Bacteria of the genus Azotobacter synthesize phytohormones; these hormonal substances, affect the growth of the closely associated higher plants. The presence of *Azotobacter chroococcum* in the rhizosphere of plants like tomato, wheat, cucumber etc. is correlated with higher germination of seeds and better growth of their seedlings. Phytohormones can stimulate root development which is released by the biofertilizer in root zone of the plants. GA like substances released by Azotobacter can enhance the leave length in cereals like wheat and maize and also grain yield (Barik and Goswami, 2003).

Nitrogen fixation:

Nitrogen is an essential plant nutrient for the vegetative growth of plants. This is widely applied as basal dose to improve growth and yield of crops. Azotobacter enhances the

mineralization process of organic residues in soil and makes availability of certain nutrients (Saikia and Jain, 2007). It also enhances the uptake of different minerals from the soil which favours efficient utilization of plant root exudates itself. Azotobacter can be a good alternative of nitrogenous fertilizers. It is a non-symbiotic species of bacteria which can fix up to 18-20kg N. $ha^{-1}Y^{-1}$ (Rawia *et al*., 2009). It favours to restore soil fertility for better crop response by availing nutrients.

Quality retention:

Azotobacter helps in retention of postharvest quality in fruits and vegetables. Quality improvement like higher oil content in oilseeds, protein content in legumes and starch content in root and tubers also reported due to Azotobacter. It helps in vigorous growth, leaves length, width, tuber growth and chlorophyll content etc. in potato and tomato respectively. It also increase earliness in vegetable crops (especially in cole crops) resulting higher yield and better quality. Banana bunch weight could be improved by application of azotobacter and organic manure supplements over 100% fertilizers.

Anti-pathogenic response:

Azotobacter spp. are capable to produce siderophore, they bind to the available form of iron Fe^{+3} in the rhizosphere of the plant, thus making it unavailable to the pathogens. There as reports that Azotobacter secretes special antibiotic substance similar to anisomycin which has fungicidal effect (Sudhir *et al*., 1983). These bacteria compete with pathogens for the food and defeat them.

Eco-friendly:

Azotobacter can be an important alternative of chemical fertilizer because it provides nitrogen in the form of ammonia, nitrate and amino acids without situation of over dosage, which might be one of the possible alternatives of chemical nitrogenous sources. So, ultimately it protects soil and environment from contamination (Namvar *et al*., 2012; Rana *et al*., 2012).

Precautions during Application of Azotobacter

There are so many points need to be remembering during applications of azotobacter. Proper ratio and quantity should be applied for treatment. Generally culture and seed ratio 1:10 is ideal for treatment. One packet is sufficient for 10 kg seeds. Culture should not be expired because it reduces the efficacy of microorganisms. Culture should not be mixed with other chemicals, pesticides and fungicides because along with chemicals it can get inactive. If one can wants to apply three treatments than order should be like this: (1) Fungicides (2) Pesticides (3) Biofertilizer

Conclusions

Azotobacter is free living, non-symbiotic, heterotrophic bacteria capable of fixing nitrogen. This bacterium synthesizes growth substances that enhance plant growth, development and yield of the plant. This types of species secrets some inhibitors which help in checking phyto-pathogenic growth. It also helps in nutrient uptake along with producing some helpful biochemical substances. It is an important component of integrated nutrient management (INM) due to its significance in soil sustainability.

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