BIOFERTILIZERS IN FRUIT CROPS – A REVIEW

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ABSTRACT

Biofertilizers are microbial preparations containing living cells of different microorganisms which have the ability to mobilize plant nutrients in soil from unusable to usable form through biological process. They are environmental friendly and play significant role in crop production. Previously it is mainly used for field crops but now-a-days it is used for fruit crops also. Biofertilizers are able to fix 20-200 kg N/ha/year, solubilize P in the range of 30-50 kg P₂O₅/ha/year and mobilizes P; Zn, Fe, Mo to varying extent. Biofertilizers are use in live formulation of beneficial microorganism which on application to seed, root or soil, mobilize the availability of nutrients particularly by their biological activity and help to build up the lost microflora and in turn improve the soil health in general. Thus the use of biofertilizer is increasing day by day due to increase in the price of chemical fertilizers, its beneficial effect on soil health and increase in production of crop.

Biofertilizer play a very significant role in improving soil fertility by fixing atmospheric nitrogen both in association with plant roots and without it. It solubilizes insoluble soil phosphate and produces plant growth substances in the soil. They are environment friendly playing a significant role in crop production. The soil lose its biological dynamism owing to repeated and indiscriminate use of inorganic source of fertilizer. The global mandate (Dorrel and Besson, 1996) today is to use organic source of plant nutrients to restore the soil health. The fertilizers are not only short in supply but costly too and produced at the cost of irreparable loss of non-renewable energy. Biofertilizers are able to fix atmospheric nitrogen in the range of 20-200 kg/ha/year, solubilize P in the range of 30-50 kg P₂O₅/ha/year; mobilize P; Zn, Fe, Mo to varying extent. They also help host plants to resist diseases and withstand stress conditions by different mechanism which vary depending upon the type of biofertilizer agent involved. Nitrogen fixing bacteria and phosphate solubilizer are the main biofertilizers for horticultural crops. These micro-organisms are either free living in soil or symbiotic with plants and contribute directly or indirectly towards nitrogen and phosphorus nutrition of the plants. According to Subba Rao (1998), biofertilizers are otherwise called microbial inoculants, are the carrier based preparation containing beneficial microorganisms designed to improve the soil fertility and help the plant growth by their increased number and biological activity in the rhizosphere. Motsara et al. (1995) reported that inoculation of Azospirillum and Azotobacter exerted beneficial effect on yield with varying physiological activities, including synthesis of plant growth promoting substances.

Biofertilizer is a cost effective renewable energy source and plays a crucial role in reducing the inorganic fertilizer application and at the same time increasing the crop yield besides maintaining soil fertility. In other words, biofertilizers are based on renewable energy sources and are ecofriendly compared to commercial fertilizers (Verma and Bhattacharyya, 1994). In the recent years, there is an urgent need to supplement the fossil fuel based inorganic fertilizers not only due to the hike in prices of chemical fertilizers but also a need is felt to maintain long term soil productivity and ecological sustainability.

MECHANISM OF BIOFERTILIZERS

The mechanism involved in the plant growth promotion by biological inoculants was given by (Okon, 1985).
i) Increased availability and uptake of nutrients

Through biological nitrogen fixation, solubilization of insoluble phosphates and mobilization of plant nutrients in more quantities are made available for crop plants by the root associated organisms. Increased nitrogen, phosphorous and potassium content of inoculated plants at different stages of crop growth have been found resulting in significant increase in grain yield.

ii) Production of plant growth promoting substances

Many root colonizing bacteria including the nitrogen fixing *Azospirillum* and phosphorus solubilizing *Pseudomonas* spp. are known to produce growth hormones which often leads to increased root and shoot growth. Plants differs in the levels and ratio of the hormones required to maintain normal growth and development. Therefore, it might be expected that at different stages of plants respond differently to invasion by hormone producing bacteria.

iii) Suppression of growth of pathogenic microorganisms

There is reduction in the inoculum density of plant pathogens due to the introduction of certain inoculants. Productions of antibiotics and bacteriocins by the introduced organisms have been suggested as possible mechanisms by which pathogen are inhibited.

ROLE OF BIOFERTILIZER IN FRUIT CROPS

The use of biofertilizer even though not spread up on a wide scale for all crops, however, there is a growing awareness among the farmers that production can be increased by the use of biofertilizers in case of cereals, pulses, oil seed and some cash crop like vegetable and sugarcane (Verma and Bhattacharyya, 1994). Biofertilizer is a recent concept in horticultural crop. Generally fruit crops have now received more attention than vegetables and ornamental crops. *Glomus fasciculatum*, *Glomus mosseae*, *Azospirillum*, *Azotobacter* and PSB are found useful for different horticultural crops. Use of biofertilizer particularly inoculation with *Azotobacter* could substitute 50% nitrogen requirement of banana and produce higher yield over full doses of nitrogen application (Tiwary et al., 1999). The absorption of mobile nutrients like nitrogen also increases in association with VAM fungi (George et al., 1992). Beneficial response of *Azotobacter* and *Azospirillum* in enhancing the productivity of banana was also reported by Dibut Alvorez (1996) and Mohandas (1996). VAM fungi are responsible for more than two fold increased acquisition of the less mobile nutrient elements like P, Ca, S, Zn, Mg and Cu from the rhizosphere (Clark, 1997). The high efficiency of *Azospirillum* for fixing nitrogen and better mobilization of fixed phosphorus by VAM even at high temperature can make these highly suited for mosambi (Manjunath et al., 1983). The per cent of wilting in VAM treated trees of guava was recorded to be lower as compared to untreated trees (Srivastava et al., 2001).

The root colonization per cent was high in *Glomus mosseae* inoculated papaya plants. Nutrient content of N, P, K and also of Fe, Mn, Zn and Cu increased due to VAM inoculation (Kennedy and Rangarajan, 2001). The improvement in yield parameters in the presence of *Azospirillum* might be due to its dual nature in nitrogen fixation and production of phytohormones substances and increased uptake of nutrients such as nitrogen (Govindan and Purushothaman, 1984). Studies on biofertilizers along with chemical fertilizers were undertaken for assessing their effect on growth, yield and quality in Mosambi (Singh, 1990).

Role of biofertilizers in fruit crops are discussed under following heads:
1. Effect of biofertilizer on growth character

Singh and Singh (2004), reported that VAM significantly increase growth of plants compared to non-mycorrhizal control and was also effective in increasing nutrient uptake by the plants. VAM influenced growth attributing character and yield attributing component. About 50% saving of phosphorus was achieved through the use of VAM. Manjunath et al. (2001) reported that VAM fungi (Glomus fasciculatum) was found to be effective in papaya in increasing the plant height, stem girth, petiole length and number of leaves. Rupnawar and Navale (2000) conducted an experiment on pomegranate and observed that mycorrhizal treatment were superior over non-mycorrhizal treatment in pomegranate. They reported that the Glomus epigaeum (GE) + G. mosseae + Gigaspora calospora mixture recorded the maximum height, root length, number of leaves, dry weight of shoot and roots and mycorrhizal dependency percentage in pomegranate.

Sharma and Bhutani (1998) investigated on the response of VAM on apple seedlings in combination with VAM, Azotobacter and inorganic fertilizers. They reported that dual inoculation with Glomus fasciculatum and Azotobacter chroococcum produce larger plants which had a more leaf area. In Egypt, Mahmoud and Mahmoud (1999) reported improvement in plant vigour with inoculation of Azospirillum on peach seedling of cv. Nemaguard as compared to control. The treatment also led to increase in plant height, stem diameter, leaf number, plant dry weight and leaf area. Jeeva et al. (1988) in Tamil Nadu found that the inoculation of Azospirillum in combination with the nitrogenous fertilizer increased the yield upto 13.1% in Poovan. The increased bunch weight was also found associated with corresponding increase in length of bunch, number of hands, length, girth and weight of fingers.

Kerni and Gupta (1986) found greatest percentage increase in seedling height of mango, seedling diameter and number of leaves with treatment 49 g N, Azotobacter + 48 g N, 32g N or Azotobacter alone as compared to control. Kumar and Shanmugavelu (1988) reported that both soil and foliar application of nitrogen and in combination with Azotobacter increase the plant height, plant girth, number of hands/bunch and number of finger/hands significantly in banana cv. Robusta.

2. Effect of biofertilizers on yield.

The beneficial effect of Azotobacter inoculation in fruit and vegetable crops was well discussed by Asokan et al. (2000). Sharma (2002) in Assam revealed significant increase in the bunch weight and yield of banana with Azotobacter and organic manures supplements over 100% fertilizer. Azotobacter also enhanced shooting and shortened crop duration. Wang in 1996 reported that with the application of Azospirillum + 150 kg N/ha can increase the yield in strawberry by 54%, the number of fruit per plant and clump weight were also highest compared to a treatment 150 kg N alone. Chezhiyan et al. (1999) studied the microbial inoculants in combination with inorganic manures which have augmented the yield and nutrient uptakes in several crops. They further reported increased bunch weight of 15.3 kg in hill banana var. ‘Virupakshi’ with application of biofertilizers (Azospirillum, Phosphobacteria and VAMF) and organic manure (FYM) along and with 75% NPK.

Fernandez et al. (1998) reported that N-fixing bacteria improved pseudostem circumference and number of fingers/hand and advanced flowering time in banana. Mansour (1998) in Egypt found that apple trees treated with phosphorene active dry yeast and nitrobene at different concentrations found effective in improving fruit yield. The
improvement was greatest with phosphorus biofertilizers. Similarly, Wang et al. in (1998) reported that there is increase in number of fruits per plant, total weight of fruits and average fruit weight in strawberry as compared to the control by the application of *Azotobacter*, *Azospirillum* and P-solubilizing bacteria. Dalal et al. (2004) reported that the yield of the sapota is greatly increased due to the application of 75 kg FYM + 1500 g N + 1000 g P₂O₅ + 500 g K₂O + 12.5 g PSB.. Benefit cost ratio is also high as compared to other fertilizer combinations.

Dibut Alvarez et al. (1996) in Cuba, studied the potential of *Azotobacter chroococcum* as a nitrogen fixer and biostimulant of banana and found that the bacteria inoculation along with N fertilizers between 80-100% favoured fruit development and also bacterial inoculation could compensate for 20% N fertilizer without changing the yield corresponding to 30 g N/ plantlets. Kohli et al. (1998) reported that use of vermicompost, farm yard manure and biofertilizers like *Azotobacter*, *Azospirillum*, VAM increase production in citrus.

3. Effect of biofertilizers on soil character

The plants inoculated with *Azotobacter* and *Azospirillum* derive positive benefit in terms of enhancement in uptake of No₃⁻, NH₄⁺, H₂PO₄⁻, K⁺ and Fe²⁺ increased nitrate reductase activity in plants and production of antifungal compounds (Wani, 1990). Gogoi (2003) reported that the combined application of inorganic fertilizer and biofertilizers in banana cv. ‘Barjahaji’ significantly increased the available NPK status, organic C and microbial biomass and dehydrogenase activity in soil after harvest. Shirsath et al. 1998 reported that VAM inoculation either singly or in combination significantly increased root and shoot dry weight as well as P uptake over non-mycorrhizal treatments. Combined inoculation of *Acaulospora calospora* + *G. mosseae* + *G. margarita* and single inoculation of *G. mosseae* were superior in increasing dry weight of ber seedlings as compared to rest of the inoculation treatments. Experiment conducted at Tamil Nadu Agricultural University by Aneesa Rani and Sathiamoorthy, 1997 on effect of organic and biofertilizers on root enzyme activity of papaya cv. Co-6 revealed that highest dehydrogenase enzyme activity in treatment substituted with 50% organic N and 50-70 per cent organic P along with biofertilizer *Azospirillum*, *Phospobacteria* and VAM.

La Rue et al. (1975) reported that application of VAM fungi in peach will help in better accumulation of Zn in their tissue. Ruiz et al. (1992) from Cuba, observed that the quantities of beneficial microorganisms in the soil increased considerably due to the use of *Azotobacter mycorrhiza* and phosphorins in banana. The commercial yield is also increased by 25-30% and save 50% of inorganic fertilizers.

In Banana, the plants of cv. Elakki Bale were studied for their response to inoculation with biofertilizer by (Mohandas, 1996) viz. VAM, phosphate solubilizing bacteria and *Azospirillum brasiliense* alone or in combination. VAM colonization was found upto 70-80% while that of PSB and *Azospirillum* was found upto 70%. The available P in the soil increased in VAM and PSB treatments and available soil N increased in *Azospirillum* treatment.

4. Effect of biofertilizers on quality parameter

Singh et al. (2000) reported that the treatment combination of ¾ P + VAM + N was the best treatment for producing better growth and yield of high quality fruit in Mosambi. This treatment also influence plant height, trunk diameter, canopy volume, root growth and biomass production as compared to control. In Egypt, the effect of biofertilizers
(phosphorene, active dry yield, rhizobacteria and Nitrobene) on fruit set and productivity was investigated on Red Roomy grape vines (Akl et al., 1997). The use of phosphorene was found to improve fruit set and yield as well as physical and chemical properties of fruits than control.

Suresh and Hasan (2001) in West Bengal evaluated the response of inoculation with *Azospirillum* and phosphobacteria on fruit quality of banana (Musa AAA) cv. Giant Governor by manipulating the doses of nitrogen and potassic fertilizers. The results revealed that inoculation of biofertilizers along with the application of recommended dose of fertilizer proved most effective in improving fruit quality of Dwarf Cavendish banana cv. Giant Governor. Rana and Chandal (1999) reported that the plant growth, yield and fruit quality of strawberry were significantly increased with the application of biofertilizer and nitrogenous fertilizers. Maximum TSS content was observed with *Azotobacter* inoculation along with 80 kg N/ha.

Tiwary et al. (1998) found a fairly high TSS and reducing sugar content in fruits harvested from *Azotobacter* inoculated banana plant cv. 'Giant Governor'. However, the effect of fertilizer in respect of total sugar and acidity content of fruit was not consistent. Sharma (2002) observed that application of *Azotobacter* + 75% inorganic N definitely improve the quality of banana viz., total sugar (16.88%), starch (2.28%) and protein (1.50%) and were recorded significantly higher the over recommended fertilizer dose.

**CONCLUSION**

Biofertilizers as a better supplement can improve the quality and yield of fruit crops. Microbial inoculants especially the VAM inoculation to the fruit plants proved the possibility of curtailing about 50 per cent P fertilizers without reducing the yield of crop. Nitrogen fixing biofertilizers mainly *Azospirillum* and *Azotobacter* can able to fix 20-40 kg N/ha and produce growth promoting substances like IAA. Use of microbial inoculants is not only a low cost technology but also it takes adequate care of soil health and environmental safety.

Generally the effect of biofertilizers on plant and yield is not as striking as that of chemical fertilizers. Since it is a living system, thus the influence is subject to environmental, biological and nutritional stresses. Moreover, the performance of the microbial inoculant depends on the quality of the inoculant and accurate specification is required to avoid poor performance of the inoculants. To become successful, this biofertilizer technology must reach to the hands of the farmers. For this, the following points must be considered:

1) More efforts be put to fully exploit the role of biofertilizers in the farmers field by means of extension activities like field demonstration, farmer's fair and training programme.

2) To enhance the efficiency of biofertilizers application measure like multiple cultures containing biofertilizers like *Azotobacter* + PSB + *Azospirillum*, *Azospirillum* + *Azotobacter* etc. can be exploited.

3) The efforts are also desired in the direction of improvement of shelf life of bioinoculant in the biofertilizers during storage. Improvement of carrier material or isolation of strains which having more shelf life can help in this respect.

4) Efforts are also desired in the direction of development of simple, low cost technologies so that farmers could be able to produce their biofertilizers at their own place economically.

**REFERENCES**

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