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Consortial Bioformulations in Plant and Soil Health Enhancement

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SUMMARY

As a part of ecofriendly pest and disease management strategy various bioactive beneficial microorganisms are being used. For sustainable and organic soil health enhancement also, role of plant growth promoting microbes (PGPM) is very well known. There are indications that mixtures of biocontrol agents (BCAs) with different modes of action are more effective in comparison to the application of single type of BCA. Literatures are also available to specify that combinations of BCAs and PGPM can increase disease suppression, improve crop yields and enhance nutrient uptake by plants over single organism inoculations. For that proper selection or screening of microorganisms, their compatibility studies before application and development of formulations is much needed steps to be followed.

INTRODUCTION

Applications of chemicals have been prescribed for the pest, disease and nutrient management, but most of these have limitations and farmers do not get satisfactory results by their applications alone. Chemicals also exert serious effects on non-target beneficial organisms and consequently hazardous threat to environment. Under these circumstances, integrated disease management warranting exploration of non-chemical methods, such as biological agents, plant products, host plant resistance, soil amendments with limited use of chemical pesticides seems to be a better option. Biological control is the reduction in the amount of inoculum or disease producing activity of a pathogen accomplished by or through one or more organisms other than man (Cook and Baker, 1983). Adams (1990) recommended proper cultivation practices considering the requirements of the beneficial microbes. Moreover, the climatic conditions must be favourable for development and maximum expression of the antagonistic activities of the biocontrol agent (BCA). Various beneficial microorganisms, *viz*., *Trichoderma* spp., pseudomonads, *Beauveria bassiana*, *Metarhizium anisopliae*, *Lecanicillium lecanii* have their potential to suppress and manage various pest and diseases of our crop plants. Further, in chemocentric agriculture, most of the farmers now a days use injudicious application of chemical fertilizers for achieving maximum productivity. Due to which sustainability of the soil is reducing and soil becoming sick. Application of various organic amendments and PGPMs have a greater role to play for improving soil health and sustainable production, both in organic and conventional cultivation practices. Various bioactive microorganisms, *viz*., *Bacillus* spp., *Rhizobium* spp., *Azotobacter* sp., *Azospirillum* sp., have their potential to fix nitrogen, solubilize phosphate and potash, etc. So we need to elaborate on the studies of indigenous microbes to develop efficient microbial consortia for enhancement of the plant growth and yield of crops.

In vitro Compatibility Study among Different Microorganisms

Materials required: 7 days old culture of microorganisms, Sterilized Petri plate, PDA/ NA media, Cork borer, Inoculating needle, Absorbent cotton, Spirit lamp, 70 % alcohol.

Procedure:

- Switch on the UV lamp of the laminar air flow desk for 15 minutes before work.
- Surface sterilizes the working desk as well as hands with alcohol.
- Light the spirit lamp on and switch on the laminar air flow.
- Keep the sterilized Petri plates, alcohol, inoculating needle, absorbent cotton, nutrient media etc. on the working bench and allow the media to cool down.
- Pour media into sterilized Petri plates and allow for solidification.
- Place two mycelial disc of 5mm diameter (cut out with cork borer) of different microorganisms (fungal origin) opposite to one another near the periphery of the nutrient plate with the help of inoculating needle. In case of bacterial microorganisms, take a loop full of bacteria with inoculating loop from the pure culture plate and streak at one side of the periphery of nutrient plate.
- Maintain three replications.
- Incubate inoculated PDA/ NA plates at 28 ± 1^{o} C for 3- 4 days in BOD incubator.

- Observation of mycelial/ radial growth of the microorganisms and zone of inhibition at an interval of 24 hours up to 96 hours of incubation.
- Where there is no zone of inhibition, the microorganisms will be considered as compatible to each other. A zone of inhibition proves the antagonistic nature of the microorganisms to each other.

Interaction of Various Bioactive Microorganisms

Kundu and Gaur (1984) studied effect of combined inoculation of *Azotobacter chrorococcum, Bacillus polymyxa and Pseudomonas striata* and found highest grain yield and nitrogen and phosphorus uptake than single inoculations in both sterilized and unsterilized soils. Jisha (2002) reported the efficiency of combined inoculation of *P. fluorescence* and *Trichoderma* in mixtures for plant growth promotion and disease suppression in different spice crops. Rudresh *et al.* (2004) reported that combined inoculation of biocontrol agent *Trichoderma* sp. and beneficial organisms like Phosphorous solubilizer and nitrogen fixer improved the growth of chickpea. Srivastava *et al*. (2010) studied the use of consortium of arbuscular mycorrhizal fungus (AMF), *T. harzianum* and *P. fluorescent* formulation for the management of tomato wilt and found significant reduction of disease in field along with enhanced growth and yield of tomato. Srinivasan and Mathivanan (2011) recorded significant reduction in the pre-and post- emergence disease incidence and increased germination of cabbage and cauliflower seedlings treated with Pathogens + *Azotobacter* sp. + *B. megaterium* + *P. fluorescens* + *B. subtilis* + *T. harzianum*. Similarly, Yobo *et al.* (2011) reported that combine application of *Trichoderma* sp. and *Bacillus* sp. significantly decreased *R. solani* damping off disease and increased plant growth and yield of cucumber. Christinal *et al*. (2012) recorded maximum chilli yields, fruit length, girth, number of seeds, fruit weight in the combined inoculation comprising of *P. fluorescens* with *Azospirillum brasilense* and *Glomus fasciculatum* when compared with single and dual inoculant. Sateesh and Sivasakthivelan (2013) also reported that co-inoculation of *P. fluorescence* in consortium with *T. viride* and *A. chroococcum* was significantly effective than dual and single inoculation in enhancing the growth and yield parameters of chilli as well as improvement in the soil health. Similarly, Maina *et al*. (2013) reported that the consortia of PGPRs and biocontrol agents enhanced the establishment of seedlings in the field. The treatment consisting of *Glomus intraradices, A. chroococcum, B. megaterium, P. fluorescens, B. subtilis* and *T. harzianum* showed significantly higher plant height, number of leaves, number of branches and plant biomass. A significantly highest number of fruits were also recorded with the highest average fruit weight (54.00 g) and highest fruit weight per plant (1.85 kg) when co-inoculated with all the PGPR. Sudharani *et al.* (2014) evaluated the effectiveness of few biocontrol agents in combination with PGPRs against damping-off and wilt pathogens of cabbage crops and found that the combination of *A. chroococcum* + *B. megaterium* + *P. fluorescens* + *B. subtilis* + *T. harzianum* could enhanced seedling vigour, total biomass, least disease incidence and higher biocontrol efficiency. Nath et al. (2016) developed a biointensive strategy using *various bioactive microorganisms,* singly and in combination and recorded highest reduction of bacterial wilt incidence (95.09 %) of tomato and increased yield in treatment combinations of *T. parareesei* + *P. fluorescens* + *B. subtilis*+ *A. chroococcum*.

CONCLUSION

Agriculturalists have increased their efforts to take advantage of natural biological antagonisms and beneficial microorganisms to develop strategies by which biological control can be achieved effectively against several plant pest & diseases and enhancement of nutrient status of soil. The application of consortial bioformulations as combination of seed treatment, root treatment, foliar and soil application promised as an effective biocontrol option along with better plant growth, yield and soil health for management of crop plants and *vis-a-vis* for cultivation of organic crop.

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