BIOTECH INPUTS FOR IMPROVING THE YIELD OF BANANA

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Abstract of the PhD thesis

This is an abstract of PhD thesis of an author submitted to the North Maharashtra University (Now Kavyitri Bahinabai Chaudhari North Maharashtra University), Jalgaon under the joint supervision of Dr R.M. Kothari and Dr S.B. Chincholkar both at School of Life Sciences, NMU, Jalgaon in 2001 and conferred in 2002.

The nutritional profiles of banana, along with established and emerging applications of banana orchard product/ by-products/ waste are initially reviewed thoroughly. In view of the potential merits, a case study has been conducted for increasing its production to meet the needs of increasing population and seize an opportunity to export. For this purpose, reasons behind the failure in meeting quality and quantity goals have been analysed in-depth. Such critical analysis has brought out that traditional methods of banana cultivation relying upon indiscriminate application of chemical fertilisers, frequency and quantum of flood irrigation, non-application of organic carbon and reduced beneficial micro-flora of soil have rendered soil saline/infertile, stagnated banana production and polluted underground aquifers. Therefore, it needs to be replaced by biotech inputs for sustainable banana production. Consideration to this theme has led to the following conclusions: (i) climate of Jalgaon district is well suited to banana cultivation; (ii) literacy profile of farmers permits adoptability of new technology; (iii) commercial cultivar, dwarf Cavendish AAA, *Basrai* variety (*Musa paradisiaca* L.), Shrimanti sub-variety, is nicely adopted and widely cultivated in this region; (iv) its six developmental phases are familiar to farmers; (v) morphology of the banana plant (root system, pseudostem, leaves, inflorescence, flowers and fruits) is thoroughly studied; (vi) fertility status of soil identified for organic carbon content vis-à-vis average banana yield; (vii) use of biotech inputs such as plant growth regulators (PGRs), soil conditioner (SC), consortium of biofertilisers, besides reduced chemical fertilisers, fly ash (FA) and drip irrigation (DI) and their rationale use ascertained through literature survey.

Since the above inputs largely constitute integrated plant nutrition management (IPNM), review of their beneficial attributes that appeal their application, is thoroughly made. In fact, historicity of individual microbes constituting a consortium of biofertilisers, its development and application is purposefully given to weed out doubts about its inefficacy and re-establish its bio-efficacy in cost-effective and eco-friendly manner. Their requirement, preparation, effect on plant growth, effect on rhizospheric micro-flora and effect on productivity are elucidated logically. Similarly, introducing the emerging concept of mycorrhizosphere elucidates occurrence and significance of native VAM in banana eco-system for several beneficial functions. Incorporation of low cost FA, a waste product of Thermal Power Stations, is suggested for soil amendment in view of its multi-faceted physico-chemical properties, similarities in composition with soil types, for sustainability as a source of supply of Ca, PO_4, K and micro-nutrients, thereby making a scientifically logical case for reducing the use of chemical fertilisers by 50%. This appeared feasible in view of varied recommendations by different researchers on the use, quantum, mode and frequency of application. With cost-effective use of water by DI, improved its utilisation efficiency and brought several advantages to farmers making it a sensible proposition.

Finally, present status of banana cultivation has familiarised major outcome of non-judicious practices followed by farmers and confirmed by the outcome of long-term cultivation experiments. This has necessitated the importance of biotech inputs for sustainable banana production, culminating into identification of major objectives of the present work, namely to explore the application of SC derived from pseudostem, PGR, consortium of biofertilisers, FA, reduced quantum of chemical fertilisers and DI for evolving a low-cost input regime for qualitative and quantitative improvement in banana productivity.

The chapter Materials and Methods gives a detailed account of materials used. This is followed by details on (i) SC-preparation from banana pseudostem, (ii) isolation of efficient microbes from elite banana mycorrhizosphere (N_2-fixers and PO_4-solubilisers), (iii) procurement of sulphur oxidisers and ectomycorrhizae, (iv) production of 20 L scale inocula of efficient species from each category to constitute a consortium of biofertilisers and (v) production of amino acids based PGR. Subsequently, a layout of RBD experimental design, incorporating 12 treatments, has been given to explore the applicability of the above biotech inputs and find out a cause and effect relationship on the growth and banana yield profiles at NMU (North Maharashtra University) and BAT (Bajirao Agro-Tech) farm trials. To enable another researcher in this field to repeat these trials elsewhere, adequate details are provided at each step of the trial. These include (a) pre-plantation preparations, (b) post-plantation care and (c) monitoring of experimental banana orchards during the trials for morphological profiles, physiological profiles, microbial profiles, VAM profiles and siderophore profiles. For completeness of the record, details of frequently used analytical methods are given. Finally, banana yield is estimated and statistically analysed for accuracy of the results. Thus, a fair attempt is made to explore if a biotech input regime has attributes to provide a protocol for sustainable production of banana, without compromising with the fertility of soil, interests of farmers and interests of banana consumers and health of eco-system.

To address the problems associated with banana production, in the chapter Results and Discussion, an integrated, cost-effective and eco-friendly technology has been evolved for enhanced quality and quantity production of banana and maintaining overall sustainability in banana eco-system. On the basis of last five years laboratory as well as field level experiments, major outcome is accounted as follows:

1. Approximately 4 million MT biomass per annum, generated by pseudostem and leaves after banana harvesting in Jalgaon district, normally disposed off by either incineration or putrefaction on the boundaries of farms, is explored for utilisation in the cost-effective production of SC, using solid-state fermentation for organic carbon and nutrients recycling.
2. Amino acid based PGR, produced by hydrolysing locally available protein-rich by-product, has imparted 20 % higher survival rate upon transplantation of plants and increase in banana productivity.
3. From the rhizosphere of elite banana plants (yielding more bunch weight), screening of soil rich in plant growth promoting microbial population gave efficient microbes to boost plant growth. They were isolated and preserved for commercial exploitation in a consortium of biofertilisers.
4. FA, has shown potential for application for soil amendment in conjunction with phosphate solubilising fungi and mycorrhizae for recycling, as a partial substitute for phosphatic and potassic fertilisers and costly, imported micro-nutrients.
5. Irrigation through drip has afforded to use minimal quantum of water, minimum consumption of

electricity, and thereby minimal rate of soil salinisation.

6. Using these biotech inputs, enhanced efficiency of chemical fertiliser use, at 50% reduced quantum is obtained, which permitted conversion of heavily eroded, barren and unused land into a cultivable agricultural land.
7. Reduction in the dose of chemical fertilisers to 50% by the synergistic use of SC, consortium of biofertilisers, endogenous VAM, fly ash and PGR along with fertigation through drip afforded optimal bioresource management and integrated nutrition for *Shrimanti* variety of *Basrai* banana, which in turn enabled to reduce mortality rate minimally by 20%, provided well ramified root system, overall vigour to plant health, increased productivity by minimum 20 % and brought more net income to farmers in environment-friendly way.
8. Trials in two geo-climatic conditions at NMU and BAT farm have shown broadly the same trend in observations and productivity, indicating the reliability of IPNM technology.

The dissertation of 168 pages is well illustrated and supported by enough figures, charts and photographs, wherever necessary and ends with a compilation of 199 references and curriculum vitae of the research scholar. The researcher gratefully acknowledge the financial support from the Development Board for the Rest of Maharashtra, Mumbai for undertaking the present study and the Council of Scientific & Industrial Research for offering Senior Research Fellowship to the research scholar for submission of thesis. The researcher also has into his credit almost few research publications in peer reviewed international journals from his thesis as followed:

1. Phirke, N. V., Chincholkar, S. B. and Kothari, R. M. (2002): Optimal exploitation of native VA-mycorrhizae for improving the yield of banana through IPNM. *Indian Journal of Biotechnology,* 1(2): 280-285.
2. Phirke, N. V., Chincholkar, S. B. and Kothari, R. M. (2005): Bioresource Management for Higher Productivity of Banana in Eco-Friendly and Cost-Effective Manner. *BRI's Journal of Advances in Science and Technology*, 8(1): 6 – 15.
3. Phirke, N. V. and Kothari, R. M. (2005): Conservation and recycling of banana orchard waste: the need of time for Indian banana growers. *Ecology, Environment and Conservation*, 11(2): 211 – 218.
4. Phirke, N. V., Chincholkar, S. B. and Kothari, R. M. (2008): Rhizobacteria in mycorrhizosphere improved plant health and yield of banana by offering proper nourishment and protection against diseases. *Applied Biochemistry and Biotechnology*, 151 (2-3): 441 – 451.
5. Phirke, N. V., Mahorkar, V. K. and Kothari, R. M. (2010) Sustainable Banana (Musa spp.) Production in Tapi basin: Khandeshi farmer's livelihood, *Acta Horticulturae (ISHS)*, 879 (2): 517–525.