THE USE OF BIOFERTILISERS FOR SUSTAINABLE TOBACCO PRODUCTION

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INTRODUCTION

Low soil fertility that sometimes results in crop failures is a major concern in crop productivity in Zimbabwe. Inadequate arable land at farm level has birthed the norm of monocropping leading to further deterioration of our inherently poor-quality soils. In response, farmers usually increase the usage of chemical fertilisers that further degrade soil fertility by disrupting the soil ecology. Thus, crop yields must be improved in a sustainable to ensure continued and profitable production capacity. One such way is the use of biofertilisers that increase plant nutrient supply whilst improving the fertility status of soils. Biofertilisers are classified as organic fertilisers that contain a significant population of a particular or a set of advantageous microorganisms for increasing soil production. They are a viable and attractive biotechnology option that can enhance crop output, improve and restore soil fertility, promote plant development, lower production costs, and lessen the environmental effect associated with chemical fertilisation.

Numerous microorganisms, such as nitrogen-fixing soil bacteria (such as *Azotobacter* and *Rhizobium*), nitrogen-fixing cyanobacteria (such as *Anabaena*), solubilizing phosphate bacteria (such as *Pseudomonas*), and arbuscular Mycorrhizal fungus, are frequently employed as biofertilisers (Fig. 1). These can be used as a blend of two or more species or applied as a single species.

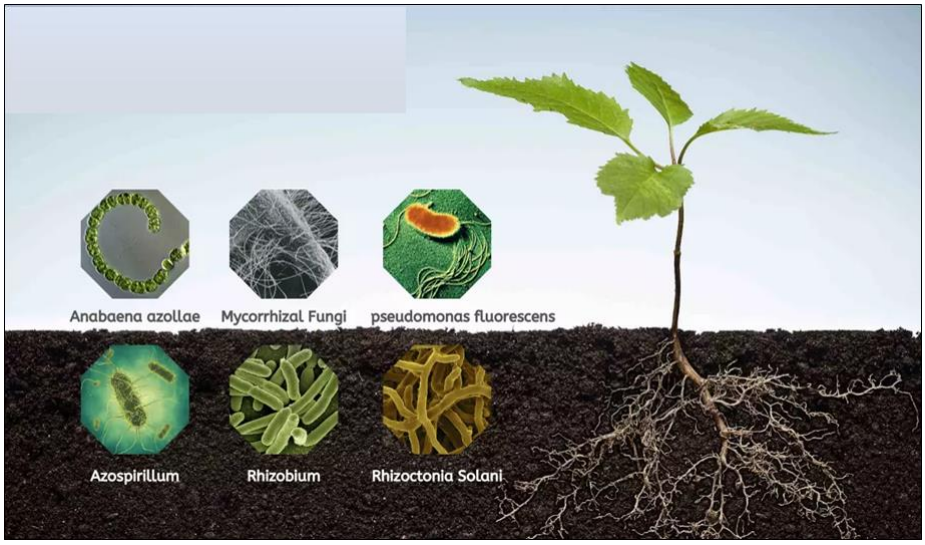

Figure 1: Common microbes used as biofertilisers

BENEFITS OF USING BIOFERTILISERS

When applied under favourable conditions, biofertilisers have been reported to boost crop output by around 25% while reducing the need for inorganic fertilisers by up to 25-50% for nitrogen and about 25% for phosphorus nutrients. They are also said to fortify soil health and offer defense against drought and some soil-borne diseases. Depending on the composition of the biofertilisers used, increases in crop yield and soil quality may emanate from:

1. **Increased soil nitrogen -** several nitrogen-fixing soil bacteria such as *Azotobacter*, *Rhizobium* and nitrogen-fixing cyanobacteria such as *Anabaena* are used to fix atmospheric nitrogen making this nitrogen available to the plant.

2. **Increased soil phosphorous availability -** Biofertilisers prepared with phosphate solubilizing microorganisms increase soil phosphorus availability through converting phosphates that are insoluble, such as tricalcium, iron, and aluminium phosphate, into soluble forms that are plant available.

3. **Increased plant resilience to abiotic stress –** some biofertiliser suspensions contain hormones that help plants cope with abiotic stresses including drought, extreme cold, water surplus or shortages, and salinity. When abiotic stress tolerance is improved, optimum growth rates are more likely to be achieved and maintained even in restricted environments.

4. **Reduced soil erosion –** some biofertilisers improve soil aggregation as they produce capsular polysaccharides thus aiding in reducing soil erodibility.

5. **Proliferation of additional beneficial microorganism -** beneficial microorganisms are crucial in crop productivity as they can aid in the production of bioactive substances such as enzymes and hormones, increase plant photosynthesis, control soil diseases, and accelerate decomposition of lignin materials in the soil.

RESEARCH IN TOBACCO DONE AT KUTSAGA

Some research aimed at evaluating various biofertilizers for effectiveness in tobacco production was done at Kutsaga (Table 1).

Table 1 below shows some of the biofertilisers that were evaluated at Kutsaga Research Station

	Constituents	Function	Rate used	Comments
1	*Lactobacillus acidophilus, Bacillus subtilis, Saccharomyces cerevisae*	Helps sterilize soil, solubilizes insoluble phosphate compounds and increase plant growth	160 L/ha	Not recommended for use on tobacco
2	*Bacillus subtilis, Enterobacter, Pseudomonas, Trichoderma*	Solubilizes insoluble phosphate compounds, biocontrol of pathogens	100 ml/5 L of water	Recommended for use on tobacco
3	*Mycorrhiza*	Provides the host plant with nutrients and increases the abiotic and biotic stress resistance of the host	30, 40 & 50 kg/ha	Not recommended for use on tobacco

This was with the main objective of reducing the use of synthetic chemical fertilisers and thus enhancing sustainable tobacco production practises. In one trial, a blend of over 30 soil micro-organisms specifically selected for their ability to rehabilitate and enhance soil fertility was evaluated in combination with 50 -75% reductions of chemical fertilisers. Yield and quality of tobacco, even with these fertiliser reductions, were comparable to the 100% fertiliser treatment indicating the ability of the biofertilisers to replace chemical fertilisers in tobacco production (Fig. 2).

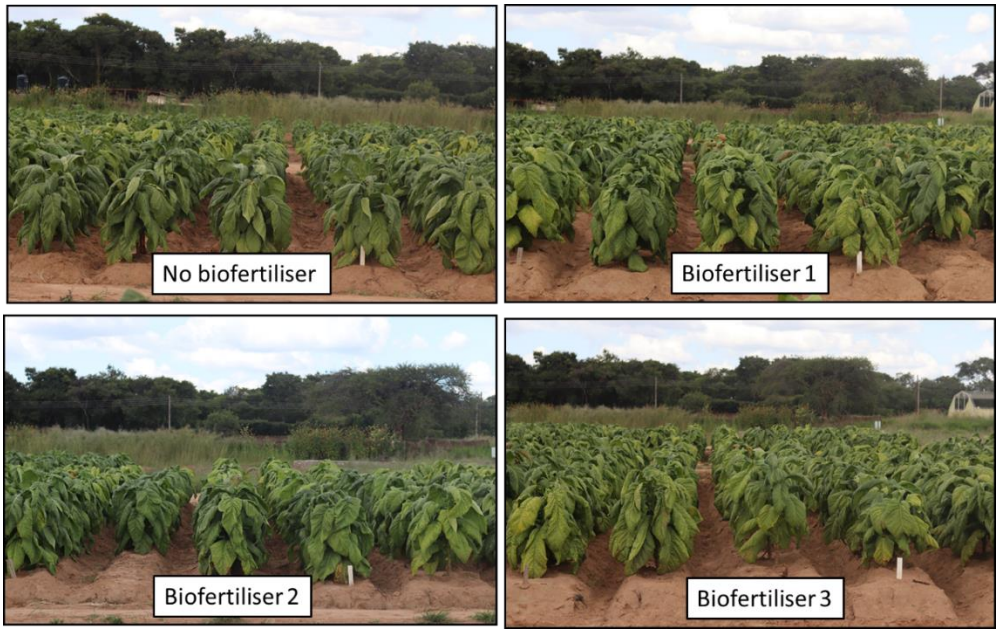

Figure 1: Evaluation of biofertilisers in tobacco showing a more robust crop under biofertiliser additions compared to the no biofertilisers treatment

In another trial reducing the nitrogen requirement by 25, 50 and 75% with the application of two nitrogen fixing bacteria (*Azotobacter vinelandii* and *Clostridium pasteurianum*) resulted in similar yield and quality to the 100% nitrogen applications.

With the objective of evaluating Mycorrhiza, fungi that form a symbiotic relationship with plant roots, a trial was also established for three seasons. It was hypothesised that application of the mycorrhiza results in development of a profuse root system greatly increasing the absorptive area of the plant leading to substantial reduction in water requirement and improved growth. Results obtained, however, showed reductions in tobacco yield and quality with continual use of this specific biofertiliser and was thus not recommended for use in tobacco production.

The trials conducted showed that for biofertilizers to be effective it is necessary that they be used under the conducive environmental conditions. Environmental conditions such as inadequate moisture sometimes due to prolonged mid-season droughts, increased soil temperatures, inadequate soil carbon levels, among others can result in ineffectiveness of applied biofertilisers. These challenges can be overcome if soil pH is maintained in the range 5.5 – 6.5 through liming, soil moisture kept adequate throughout the season, soil organic matter boosted through incorporating crop residues during land preparation and soil temperature maintained below 30 °C by maintaining soil cover and irrigating during hot periods. In addition, research has advanced to produce biofertiliser suspensions that contain a carbon source to circumvent the obstacle of low soil organic matter.

CONCLUSION

The Tobacco Research Board is expanding research on the use of microorganisms to improve crop nutrition and the ability of crops to resist abiotic and biotic stress. This is one of the sustainable production approaches that can enable reductions in the use of inorganic fertilisers, herbicides, pesticides and water that have a negative impact on the environment.

For more information, contact Kutsaga Research Station's Crop Productivity and Molecular Technologies Division on telephone # (263- 24) 2575 289-94, or VOIP 0868 800 2604 or Email: tobres@kutsaga.co.zw or visit Kutsaga Research Station on Airport ring Road, Harare.