SCD Probiotics

White Paper:

Application of SCD Probiotics Technology for Crop Production

SCD Probiotics Technology

Background

Sustainable Community Development, LLC ("SCD"), based in Kansas City, Missouri, USA, is a company specializing in natural microbial-based products and services for human health, agriculture industry, industrial waste management, and environmental sustainability. Through 10 years of research and development, SCD has selected 14 different microbial strains for production of various probiotic products. These include lactic acid bacteria such as *Lactobacillus* spp. and *Streptococcus sp.*; yeast such as *Saccharomyces* sp.; photosynthetic bacteria such as *Rhodopseudomonas* spp.; and other beneficial bacteria such as *Bacillus* sp.

In essence, the SCD Probiotics Technology is a consortium of lactic acid bacteria, phototrophic bacteria, nutritional yeast, and other beneficial microorganisms. SCD's consortium culture synergistically works to inhibit the growth of pathogenic harmful bacteria through competitive exclusion. Competitive exclusion effects, the metabolites produced by the consortia and its chemical characteristics contribute to antimicrobial properties and health benefits. Average pH of the product ranges from 3.2-3.5. Some products with SCD Probiotics Inside microorganisms consortium can include, for instance, *Lactobacillus acidophilus, L. bulgaricus, L. casei, L. fermentum, L. plantarum, Rhodoseudomonas palustris, Saccharomyces cerevisiae, Streptococcus thermophilus*, etc. These microorganisms have been known to be associated with human foods and are ubiquitously used in the manufacturing of probiotic dietary supplement products for human, animal, and aquaculture health.

While the traditional meaning of the word "probiotic" is applied to human and animal digestive microorganisms, SCD is on the cutting edge of developing technology to apply the concept of "probiotics" to many fields globally including wastewater treatment, odor control, environmental bioremediation, agriculture, pest control, mold

remediation, industrial and home agriculture, aquaculture, gardening, prevention of skin diseases, turf grass, composting, and other fields.

SCD Probiotics Technology and Certifications

All SCD products are manufactured under high and strict quality control standards. Products are manufactured in a food grade facility utilizing food grade equipment, raw materials, and utensils. SCD complies with the Food Grade current Good Manufacturing Practices (cGMP). These guidelines are enforced in the United States by the Food and Drug Administration. GMP guidelines provide a system of processes, procedures, and documentation to ensure the product produced has the identity, strength, composition, quality, and purity that it is represented to possess. Information about SCD Probiotics Technology can be found at www.SCDProbiotics.com.

The Organic Materials Review Institute (OMRI) provides certifiers, growers, manufacturers, and suppliers an independent review of products intended for use in certified organic production, handling, and processing (Organic Materials Review Institute, 2006). OMRI's services are directed at all aspects of the organic industry with a primary focus on the decision makers who deal with the compliance status of generic materials and brand name products. With the OMRI *Generic Materials List* and OMRI *Products List,* OMRI provides guidance on the suitability of material inputs under the USDA National Organic Program standards (Organic Materials Review Institute, 2006). Many SCD products are certified with OMRI as "safe for use in organic production." Please visit **www.omri.org** for more information and to verify SCD's registered status.

SCD's compliance with the above-mentioned regulatory agencies illustrates the safety and quality of the products manufactured as well as the routine testing that has been conducted over the past two years. SCD products are routinely tested both in-

house and by third party independent laboratories for the incidence of pathogenic activity, heavy metals, and mycotoxins. Certificates of analysis of ProBio Balance™ Plus are enclosed.

ProBio Balance Plus is recommended for use in livestock, agriculture, and environmental applications. It can be used to manufacture secondary products such as SCD Bio Ag® for specific applications in the areas of agriculture and composting. The secondary products are as follows:

SCD Bio Ag: This is an all-natural probiotic inoculant, recommended for soil application, which contains exclusive microbes and their metabolites. SCD Bio Ag is environmentally safe and distinctly effective at improving soil quality.

SCD Plant Saver™: This is an all-natural probiotic inoculant, recommended for prevention of fungal and virus-related plant diseases, which contains exclusive microbes and their metabolites. SCD Plant Saver is environmentally safe and distinctly effective at preventing plant diseases.

Crop Applications of SCD Probiotics Technology

The application of beneficial microorganisms is an economical and simple way to increase crop yield, alleviate environmental pollution, and control diseases. A number of studies have been designed to investigate the effect of probiotics as microbial inoculants in crop production. Positive outcomes of the growth, yield, and physical response have been postulated for sweet corn (Zhengao et al., 2006; Xu, 2000), rice (Lee and Sho, 2006; Primavesi, 2006; Iwaishi, 2000), tomato (Xu et al., 2000), soil properties and citrus (Paschoal et al., 2006), and tobacco (unpublished data).

Xu (2000) reported that sweet corn plants in probiotic plots showed slightly higher dry mass under all fertilizations at most growth stages. Probiotic application

showed a positive effect on relative growth rate and net assimilation rate at all growth stages under both organic and chemical fertilizations. Grain yield and harvest index were found to be higher in the probiotic plot (Xu, 2000). Consistent results were found by Zhengao et. al. (2006) who reported that the yield from one hectare of plants grown with organic matter and probiotics has 1,410kg more than that grown with other treatments. In addition, the content of sugar also increased after probiotic application.

The yield increase due to probiotic treatment for all rice varieties, except brown rice, ranged from 8 to 19% (Iwaishi, 2000). Probiotic treatment was found to be beneficial in increasing the grain number, ear number, length, and kernel weight, consequently increasing yield of rice variety. For glutinous varieties, it was found that the glutinousness of rice in the probiotic-treated plots was higher than the non-probiotic treated plots (Iwaishi, 2000). It was observed that there was no significant difference in growth during early stages. A higher growth rate was found during the maturing stage, which is likely the result of enhanced plant growth from probiotic treatment after panicle formation.

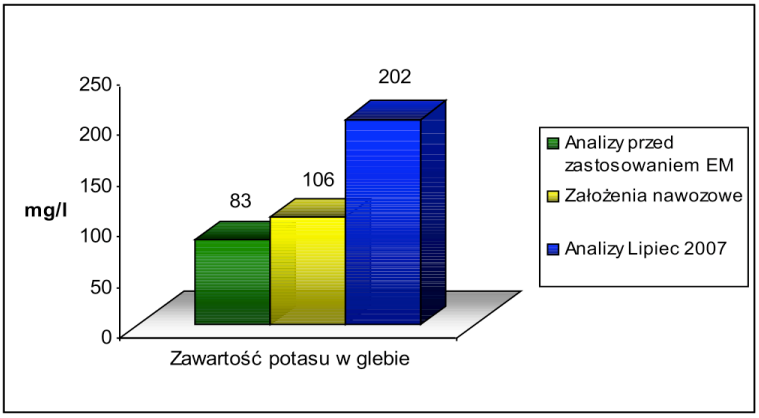
Paschoal et. al. (2006) summarized the following information: analyses of the chemical characteristics of the soil and citrus leaves indicated: 1) a significant (P<0. 05) increase in the organic matter content of the soils that were treated with probiotics at both the 0-20 cm and 20-40 cm depths can be attributed to the probiotics' humus forming capacity from dead grass mulch; 2) a significant (P<0. O1) increase in soil pH at both sampled depths in the probiotic-treated lots is an indication that probiotics alone can change soil reactions; 3) a significant (P<0. 05) increase in soil CEC at both depths in the plots treated with probiotics can be related to the enhanced soil organic matter formation; and 4) no statistical differences for any of the other chemical parameters in the soil or for the macro- and micronutrients in citrus leaves was found. The effect of probiotics on nitrogen and phosphorus in rhizosphere has been studied. The growth, yield, and nodulation of plants grown in the presence of organic amendments, especially

those with low C:N ratios, were enhanced by probiotics. The nitrogen and potassium levels in the rhizosphere were also significantly increased. These results could account for the higher crop yields that are often reported when organic systems are inoculated with probiotics (Sangakkara, 2006).

Disease and pest control

As a soil inoculant, probiotics have been reported to decrease the inoculum density of several crop pathogens (Castro et al., 2006; Lin, 1991; Higa and Wididana, 1991). Inhibition of fungi and bacteria by probiotics such as efficient microbes was investigated by a double-layer plate method. Colony diameters of fungi (*Sclerotium rolfsii, Pythium sp., Rhizoctonia solani, Colletotrichum gloeosporioides, Alternaria sp., Thielaviopsis paradoxa, Phytophthora capsici, Aspergillus sp., Fusarium moniliforme and Fusarium oxysporum f.sp. phaseoli*) and numbers of bacteria (*Xanthomonas campestris pv, vesicatoria* and *Pseudomonas solanacearum*) were compared with untreated controls after 24 or 48 hours of incubation. Phytopathogenic fungi and bacteria were inhibited by probiotics.

(Unpublished data) Philips Morris in Poland experimented with the use of SCD's secondary products to begin a "soil healing" program in 2007. The experiment objectives were to use SCD Probiotics Technology to improve soil quality and to control tobacco fungal and viral disease. Soil analyses were done before the application of SCD Bio Ag. After one year of application, soil nutrient contents had increased when compared to soil treated with fertilizers (Figure below).



*Green bar represents potassium content without SCD Bio Ag, Yellow bar represents potassium content with chemical fertilizer, Blue bar represents potassium content with SCD Bio Ag.

An increase of phosphorus, magnesium and calcium soil nutrients was also observed. Soil pH improved to such an extent that liming was unnecessary.

SCD Plant Saver was applied on a farm that was infested with aphids. The results indicated that honey-dew left by the aphids, which could cause fungal disease, had disappeared. In addition, positive results were found in vivo whereby SCD Plant Saver showed competitive exclusion protected against fungal disease in the tobacco leaves. It was postulated that SCD Plant Saver could be used to resolve the problem of fungal diseases such as *Sclerotinia sclerotiorum, Thielaviopsis basicola, Rhizoctonia solani, Peronospora tabacina,* and *Botrytis cinerea.* Further field study is an ongoing project for 2008-2009. The group of farmers cultivating tobacco for Philip Morris in Poland currently are using SCD Bio Ag and SCD Plant Saver on 240 ha of land to both control fungal and viral tobacco disease and to treat soil prior to tobacco cultivation.

Controlling root rot of strawberries with probiotic inoculant was studied by Jonglaekha et. al. (2006). The pot experiment showed that soil mixed with inoculum of *Rhizoctonia* causing root rot was controlled when a solution containing probiotic efficient microbes (1:1000) was applied 4-6 times at weekly intervals. In addition, plant growth was stimulated significantly when compared with plant growth in the control pot.

The suppressive effect of probiotic inoculants on the bacterial leaf blight pathogen *Xanthomonas oryzae pv. Oryzae* was investigated using the susceptible rice variety *Taichaung Native 1* (Lwin et al., 2006). The results suggested that probiotic microbes can be used to inhibit the growth of pathogenic bacteria; the longer the probiotic was allowed to stand on the rice, the more the disease severity was lessened. The time required to ensure good suppression ranged from fifteen minutes to one hour.

Nasiruddin and Karim (2006) compared the efficacy of a probiotic microbe inoculant, neem plant extract, and chemical insecticides in reducing the damages caused by the red pumpkin beetle (*Aulacophora foveicollis*) and the melon fly (*Bactrocera cucurbitae*) in cucurbitaceous vegetable crops. The application of the probiotic inoculant reduced beetle infestation by 38% over the untreated control. This result was not significantly different from that of the neem plant extract. The use of chemical insecticides indicated an 80% reduction of infested leaves compared to the infestation level of the untreated control.

Conclusion

The probiotics technology within SCD Probiotics creates an opportunity to reduce the quantity of chemical fertilizers needed as well as the quantity of pesticide and insecticide. A number of plant varieties have been studied and positive results were found from those varieties. Microbial ecology can be improved with the use of probiotics, thus enhancing soil properties and increasing the amount of soil nutrients available to plants.

SCD Probiotics Technology Benefit Analysis

The successful application of SCD Probiotics Technology is expected to have the following impact on crop applications:

- Improve soil quality
- Improve soil microbial ecology
- Reduce or eliminate the use of chemical fertilizers
- Control or prevent plant diseases.
- Improve production yield
- Reduce overall costs