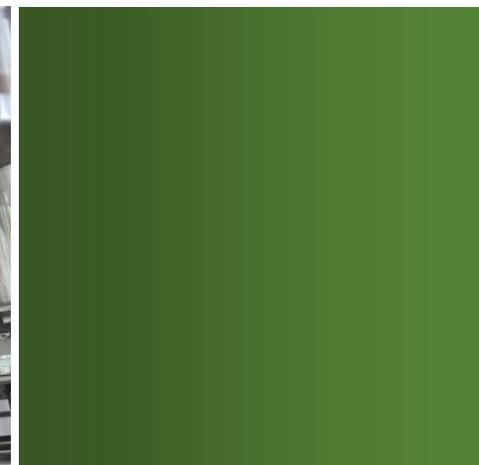


Abstract for Production of Organic Fertilizer and Pesticide

Abstract for production of organic fertilizer based on shrimp shell powder processing and pesticide based on chitosan



INTRODUCTION

Why Fertilizing?

Over centuries, the growth of agriculture contributed to the rise of civilizations. 2,000 years ago, much of Earth's population became dependent on agriculture. For thousands of years, agricultural development was very slow. A period of important agricultural inventions began in the early 1700s leading to a dramatically increased food production in Europe and European colonies. In the early 1800s, scientists discovered which elements are most essential for plant growth: nitrogen, phosphorus, and potassium. Now, many farmers use chemical fertilizers because they greatly increase crop yields. With the use of chemicals, crop

losses and prices have declined significantly.

Nowadays, chemical fertilizers can be easily replaced with organic fertilizers as a more advanced product with great benefits compared to the chemical one.



A nutrient-rich soil represents the mandatory base for healthy and strong plants and increases crop yield

Food production must keep pace relative to population growth and distribution methods. Food production has to increase by 70% by 2050 due to increasing global population. This is an enormous agriculture and political challenge.

Especially fungal diseases reduces harvest and crop yield during transport and storage. This loss can be easily avoided by the application of pesticides, but the growing awareness of healthy food leads to an increasing rejection of chemical food treatment and trend towards organic food. Based on this fact and growing income levels, the market for organic food products is growing significantly with biopesticides as a suitable alternative for organic food production.

ORGANIC SHRIMP SHELL FERTILIZER

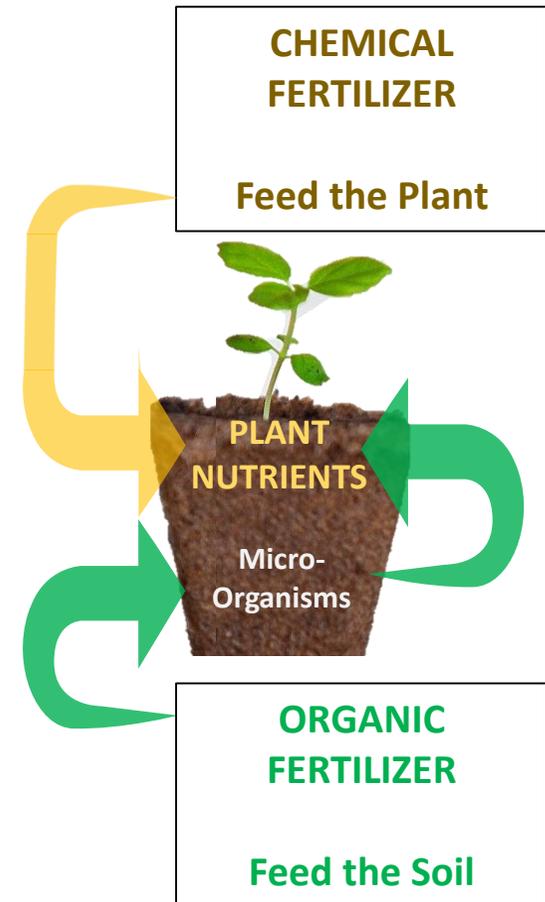
Many Potential Sources

Biofertilizer can be derived from many organic plant or animal waste, examples include manure and compost as well as bone and cottonseed meal. Exemplary, the use of shrimp shell processing waste creates profit from unutilized waste, that would be disposed alternatively. The organic components are break down by microorganisms in the soil to release the nutrients. Hence, biofertilizers feed the soil to improve the plant growth, while chemical fertilizers feed the plants directly. Chemical fertilizers won't help to sustain the soil or improve the soil structure, they can even be easily overdosed, change the soil pH value and increase diseases.

Many Advantages for Organic

Organic matter as fertilizer source has many advantages compared to the chemical one and the most important ones are:

- **Biofertilizers are renewable, biodegradable and sustainable**
- **Biofertilizers improve the structure of the soil and increase its ability to hold water and nutrients**
- **Biofertilizers won't over fertilize and harm your plants due to the slow release of nutrients**
- **Biofertilizer production creates profits from unutilized waste**



CHITOSAN BASED BIOPESTICIDE

Plants can be infected by various virus, fungus and bacteria effecting growth, harvest yield and product quality. Additionally, long distance transports enhances need for extended storage shelf life. This leads to the high global demand for pesticide for avoiding these aspects.

No artificial pesticides are allowed to be used without losing organic certification.

Due to the growing global demand for healthy organic food, the demand for organic pesticide alternatives is growing simultaneously. Chitosan represents one of these organic alternatives.

The antifungal and antibiotic effects of Chitosan has been widely scientifically proven and the application is already common for the production of organic food. Chitosan Nanoparticles (NPs) and specially selected molecular weights for the respective application even shows a stronger effect.

Chitosan is a polysaccharide derived from chitin. With chitin as major component of many exoskeletons in nature, the most common source for chitin are crustaceans processing waste. Other sources for chitin, e.g. insects and fungus, are becoming more and more important and are being researched. It is expected that they will play a bigger role in the future.



Chitosan Biopesticide coated fruits (left picture) has an extended storage time and less loss by e.g. blue fungus compared to uncoated ones (right picture).

LIQUID BIOFERTILIZER AND BIOPESTICIDE APPLICATION

Depending on producing either liquid or solid biofertilizer, the application is differing a bit. Liquid biofertilizer has a lower nutritional value in general compared to the solid one due to the production process, but liquid fertilizer is easier to apply and dose than solid powder fertilizer. Liquid fertilizer can be diluted in water and applied by spraying or dripping on the field. Solid powder fertilizer is the cheaper alternative that is dispersed directly to the field and, hence, more difficult to dose. The disadvantages of both products are far exceeded by their individual advantages and the advantages of biofertilizing in general.

The soil for agricultural plants should be fertilized regularly to improve the nutritional value decreasing over time. For good results, organic fertilizers could be applied e.g. every two weeks starting before sowing until harvest, so the nutrient release is very stable throughout the growth cycle.

Biopesticide can be applied in the same way. For a better effect, it is very important to repeat the application regularly. Biopesticide can be applied to the plants throughout the growth cycle for disease control. Harvested fruits can be coated to extend the time for transport and storage and to improve the product quality.

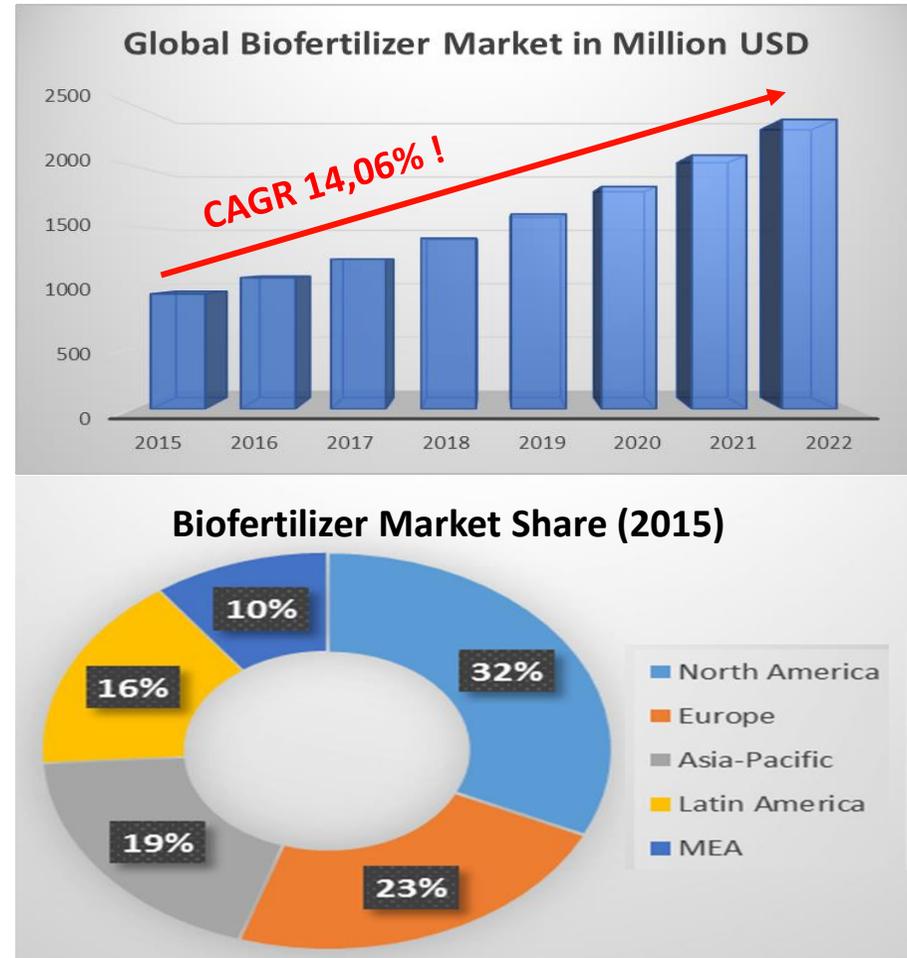


Diluted liquid biofertilizer can be sprayed on the field (picture above) or by dripping it to the plants e.g. in greenhouses (picture not shown). Biopesticides can be applied in the same way.

GLOBAL FERTILIZER MARKET

The global biofertilizer market had reached a market volume of approximately 1 billion USD in 2015 and is expected to grow with a CAGR of 14%. Hence, the **biofertilizer market will reach a volume of 2 billion USD in 2021.**

The biggest market for biofertilizing products is located in North America followed by Europe, but especially the markets in developing countries is growing even much faster due to first time applications of fertilizers in general. Many of these countries are producing agricultural products for the markets in North America and Europe. Due to the fact, that the demand of healthy organic and exotic food is increasing, the demand of biofertilizers in those supplying countries can be expected to grow stronger than the total fertilizer demand.

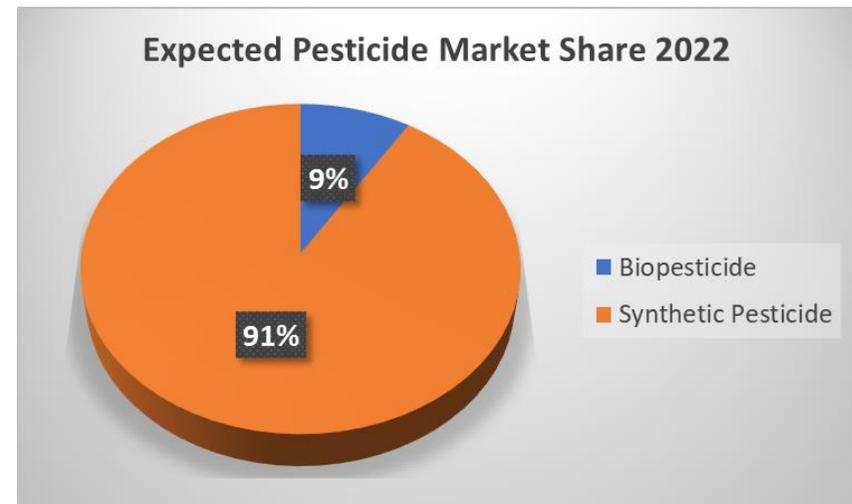
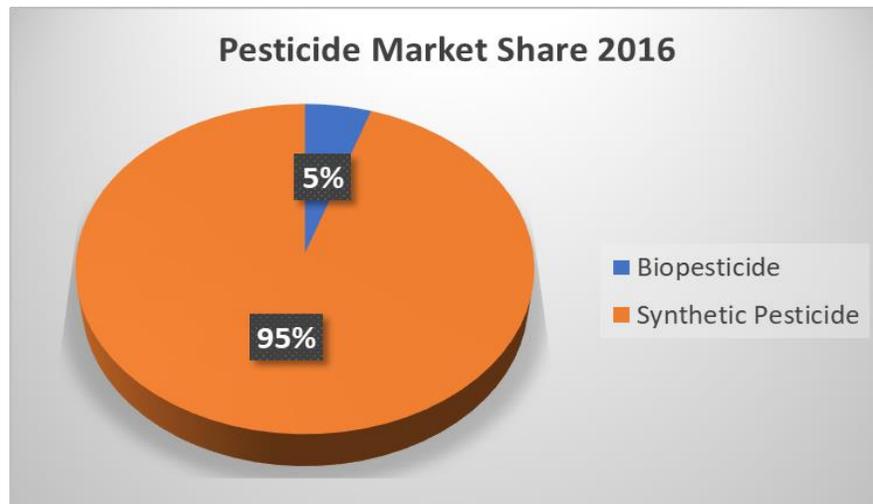


GLOBAL PESTICIDE MARKET

Pesticides represents a state-of-the-art tool for improving plant health and increasing harvest while decreasing plant diseases and harvest loss during transport and storage. Hence, the global demand

for pesticide is growing constantly. **The market volume of pesticides ingeneral has reached 59 billion USD in 2016** and is expected to grow by a CAGR of approximately 4%. Biopesticides had a market

share of 5% in 2016 and shows even a stronger growth with a CAGR of 14% than the synthetic pesticides. So the market volume of biopesticide is expected to reach a global market volume of 6.6 billion USD in 2022!



Biopesticide even shows a stronger growth than synthetic pesticides. The pesticide market had a volume of 59 billion USD in 2016.

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