Development and application of the plant microecological preparation

Zhang Li xia
zhanglixia6240@163.com

Department of Plant Pathology China Agricultural University
Zhong Nong Lv Kang Biotech Co. Ltd
土壤板结  soil hardening

水体污染  water pollution
The problem of agricultural production
We have destroyed a third of Earth’s farmland in 40 years

• Soil is being destroyed 100 X faster than it can form
• To avert disaster, farmers must adopt sustainable agricultural practices based on ecological principles.

http://news.sciencemag.org/sifter

USDA NRCS SOUTH
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We Need a New Green Revolution

By PHILLIP A. SHARP and ALAN LEHNER  JAN. 4, 2016
Introduction

- Environmental problems;
- Food safety;
- Using beneficial microbes is a promising solution for sustainable, environmentally friendly agriculture;
- Requirement from consumers;
- Strong support from the government.
Ecological agriculture

Practices that require greater reliance on natural soil processes, native microorganisms, and the interactions between plants, animals, and humans.
植物体自然生态系（1980年）——植株由细胞、组织、器官和系统与微生物组成的复合体，通过调节其微生态系统，保持微生态平衡，提高植株的健康水平，达到增产、抗病抗逆和改善品质等作用效果。

植物微生态学——通过调节控制植株体内有益微生物与病原物的生态平衡，将病害发生降低到允许的范围内。
What is Plant Micro-Ecological Preparations?

• Plant Micro-Ecological Preparations (PMEP) are the live microorganisms which confer a health benefit on the host plant. It consists of a taxonomically defined microbe or combination of microbes (genus, species, and strain level) which modify the micro-flora in rhizosphere, phyllosphere and endosphere, and reduce the harmful microbes at a certain level by adding useful microbes to keep the balance of the micro-ecosystem. It also help the transformation of the fixed N, P, K into absorbable in the soil, improving soil organic matter content, inducing plant resistance and finally keep plant health.
General Idea

Establishing microbe library

Screening and obtaining strains with growth-promoting or/and biocontrol activity

Modes of action

Fermentation

Products

Application and Extension

Source?

Active gradients in preparation?

How to transfer to products?

Measures to manage disease?
Screening model

- *Bacillus* against apple ring rot disease

Isolation → Purification → In vivo assay

Antagonistic assay, Active ingredient detection
PCR detection, Biofilm formation

Pre-harvest treatment → Post-harvest treatment

Li et al., 2013, Plant Pathol. J. 29(2)
<table>
<thead>
<tr>
<th>作用机制</th>
<th>Modes of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>次生代谢产物—吲哚乙酸、赤霉素、抑菌物质等</td>
<td>Production of Secondary metabolite: indoleacetic acid, gibberellin, antibiotics, volatile organic compounds, and extracellular cell wall-degrading enzymes.</td>
</tr>
<tr>
<td>诱导植物产生抗病性—PAL, SOD等酶类</td>
<td>Induced resistance;</td>
</tr>
<tr>
<td>定殖及微生态调控</td>
<td>Regulation of the micro-ecosystem</td>
</tr>
<tr>
<td>重寄生作用</td>
<td>hyperparasitism</td>
</tr>
<tr>
<td>营养和空间竞争</td>
<td>Nutrient and space competition</td>
</tr>
</tbody>
</table>
Production of antimicrobial compounds: Diffusible antibiotics, volatile organic compounds, and extracellular cell wall-degrading enzymes.

Ben Niu, Journal of biotechnology, under review
Trichoderma could hyper-parasite on phytophthora and kill the mycelia.
**Induced resistance**

Trichoderma-induced increase in the activity of enzymes associated with disease resistance, which enhances the resistance of plants against pathogens.

![Graphs showing enzyme activities over time](image-url)
Colonization and transfer of *B. cereus* 905 in plant

- The first leaf: 14 days
- The second leaf: 21 days
- Root: 7 days

**Graph:**
- X-axis: Days (0, 7, 14, 21, 28, 35, 42, 180, 190)
- Y-axis: Population (Log CFU/g fresh weight)
- Stem base
- Root
- Leaves
接种后3个月内内在三种土壤中均能检测到枯草芽胞杆菌，且在根际和非根际中定殖趋势相同。

There is no difference with colonization among bacteria in different soils when the cucumber was treated with Bacillus.
利用分子标记、基因突变等技术，证实芽胞杆菌能够在植株体内定殖转移，并发现了鞭毛蛋白基因、趋化蛋白基因和Mn-SOD基因等与定殖相关。

Some genes which associated with flagellin, Chemotactic protein, and Mn-SOD are related to its colonization.

Yongjun Wang, Annual Microbiology, 2011, 61(2), 355-360 , IF: 0.358
利用DGGE技术分析，芽胞杆菌促进植株体内有益菌群种类和数量增加。The richness of the bacterial community was increased when treated with PMEP.

R&D model

Industry-University-Research (IUR) collaboration

- Resource library
- Screening model
- Modes of action
- Fermentation
- Biofertilizer
- Biofungicide, biobactericide
- SOD preparations
- Feed additives
Production base
Beijing Badaling Economic Development Zone, Yanqing County, Beijing, China
规模化生产工艺
Mass production process

- 发酵工艺：液体发酵（主要）和固体发酵
  - fermentation process: liquid fermentation and solid fermentation

- 制剂工艺：水剂、粉剂、颗粒等加工制备
  - preparation technology: water aqua, powder, particle
产品

01  绿康威系列
02  微生物菌剂
03  防线虫菌剂
04  抗重茬菌剂
05  有机物料腐熟剂
06  土壤调理剂
07  绿地康系列
08  滴灌肥系列
Plant Micro-Ecological Preparations

Strain: Bacillus and Trichoderma sp.

Preparation: water aqua, powder, particle

Method of application: seed dressing, base fertilizer, root-irrigation, drop irrigation.

Range of application: vegetable, fruiter, crop, herbal medicines
2013年，Beijing，发病率小于20%，增产达到15-36%。
Morbidity less than 20%, yield increase 15-36%.
Application of PMBP on eggplant

- 2011 year, Inner Mongolia, Grew significantly better than control.

2011年，内蒙古，株高增加，叶片增大，土传病害减轻，促生效果明显。

2011 year, Inner Mongolia, Grew significantly better than control.
抗重茬微生态制剂在甘蓝上的应用

Application of PMBP on cabbage

- 2015年，福建省，处理区平均单果重是1.56kg/颗，亩产量是9366kg/亩；对照区平均单果重1.06kg/颗，亩产量是6372kg/亩，增产46.99%。

- 2015, Fujian, the average weight of the treated is 1.56kg, but control is 1.06kg, acre yield is 9366kg, but control is 6372kg, yield increase 46.99%.
抗重茬微生态制剂在洋葱上的应用
Application of PMBP on onion

- 2015年，内蒙古，增产27.7%。
- 2015, Inner Mongolia, yield increase
2015年，福建，芹菜处理区平均株高57.88cm，对照区平均株高46.43cm，增产24.66%。

2015, Fujian, celery, plant height treatment: 57.88cm, control: 46.43cm, yield increase 24.66%
抗重茬微生态制剂在生菜上的应用
Application of PMBP on lettuce

- 2015年，北京，叶片浓绿，叶面积大，死苗率比对照降低17%。
- 2015, Beijing, leaves is bigger and more green, disease reduce 17%.
Application of PMBP on pumpkin

- 2015, Inner Mongolia, yield increase 8.6%.
抗重茬微生态制剂在大蒜上的应用
Application of PMBP on garlic

• 2016年，江苏，处理区，根系发达，防病效果75.01%，增产41.18%。
• 2016, Jiangsu, treatment, yield increase 41.18%
抗重茬微生态制剂在马铃薯上的应用
Application of PMBP on potato

<table>
<thead>
<tr>
<th></th>
<th>yield (kg)</th>
<th>rate of growth (%)</th>
<th>commodity rate (%)</th>
<th>disease index</th>
<th>Control effect (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015年</td>
<td>CK</td>
<td>2346.9</td>
<td>—</td>
<td>68.5</td>
<td>55.8</td>
</tr>
<tr>
<td></td>
<td>treated</td>
<td>3248.5</td>
<td>38.4</td>
<td>84.1</td>
<td>17.7</td>
</tr>
<tr>
<td>2016年</td>
<td>CK</td>
<td>3122.4</td>
<td>40.1</td>
<td>71.8</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>treated</td>
<td>3577.5</td>
<td>14.6</td>
<td>76.7</td>
<td>29.6</td>
</tr>
</tbody>
</table>
抗重茬微生态制剂在甜菜上的应用
Application of PMBP on beet

2013年-2016年，内蒙古，死苗率减少57.3%以上，增产最低5.3%，最高80.62%，糖度增加2度，降低了甜菜制糖生产成本。

2013-2016, Inner Mongolia, yield increase 5.3-80.62%, sugar degree increase 2, which reduces the production cost of sugar by beet.
2015年，吉林，处理区的人参水根发达，单参重量增加，形状好，三年人参如五年参。

2015, Jilin, ginseng growed for three years was big as ginseng for five years.
Application of PMBP on Chinese yam

- 2015年，河北，出苗率增加，植株健壮。
- 2015, Hebei, emergence rate was increase, the plant was stranger.
抗重茬微生态制剂在烟草上的应用

Application of PMBP on tobacco

2016年，河南，烤烟苗毛根比对照明显增多。

2016, Henan, root obvious increase
抗重茬微生态制剂防治向日葵黄萎病
Application of PMBP on sunflower

<table>
<thead>
<tr>
<th>年</th>
<th>2012-2015年</th>
<th>内蒙</th>
<th>向日葵黄萎病防治效果</th>
<th>80%以上</th>
<th>增产35%</th>
</tr>
</thead>
</table>

**情况属实，建议大面积推广应用。**

2015年9月7日

专家组组长：张强
抗重茬微生态制剂防治棉花黄萎病
Application of PMBP on cotton

- 2013年-2015年，新疆兵团，棉花增产11.7-18.2%，黄萎病防效34-40%。
- 2013-2016, Sinkiang, yield increase 11.7-18.2%, verticillium wilt control efficiency was 34-40%.
抗重茬微生态制剂在草莓上的应用

Application of PMBP on strawberry

2012年－2014年，北京市，株高增加7.9厘米，叶片数增加4个，
死苗率减少22.3%，开花株数增加59株，单果增加2.1克－7.3克。
2012－2014, Beijing, strawberry was better in seedling stage and flowering phase used PMBP
绿康微在黄瓜上的应用
Application of PMBP on cucumber

2015年，山东省，霜霉病、细菌性角斑病有预防效果。
2015, Shandong, downy mildew was controled.
Application of PMBP on fruit

- Applied in 13 provinces for orange, tomato, etc., 25 types of fruits and vegetables.
- Developed the "Tianrui" SOD functional apple brand, with an increase of 3000 yuan per acre.
PMBP application field
Materials and Methods

**Bacilli spore preparation.** Three bacilli preparations consisting of industrially formulated endospores were used in the experiments. The preparations contained a final concentration of above $1 \times 10^7$ colony forming units (CFU) per g of dry weight sample. The formulation of three bacilli is referred to as a biopreparation. The biopreparation used in the current study was supplied by China Agriculture University (Beijing, China) and the three bacilli included in it were strains B83-10, M22 and B-319. Strain B83-10 was isolated from Chinese cabbage and identified as *B. cereus*. It previously showed severe yield-increasing activity on Rapeseed. Strain M22 was isolated from sugar beet and identified as *B. cereus*. Strain M22 showed growth pro-
为表彰在推动科学技术进步、对首都经济建设和社会发展作出贡献者，特颁发此证，以资鼓励。

获奖项目：
益微SOD的研究与应用

获奖者：王 琦

获奖等级：贰等奖

北京市科学技术奖

No 2005农-2-015-01

河南省科学技术进步奖

为表彰河南省科学技术进步奖获得者，特颁发此证书。

项目名称：SOD功能苹果生产技术研究

奖励等级：叁等奖

获奖者：王 琦

奖励日期：2005年01月

证书号：2004-167

2005年12月19日

证书号：2005-J-198-R03/07
北京生物新技术“治好”内蒙古作物土传病

转职能强服务 开创京蒙科技合作新局面
Products and patents:
Awards

• Development and Application of Biological fungicides with *Bacillus*-------National Science and technology award (the second class)
Thanks for your attention