Saying Goodbye to Soil Fumigants In Strawberry Fields:

An Effective and Responsible Approach

While the routine use of pre-plant soil fumigants has become standard practice for many strawberry growers over the years, problems with product availability, health and safety restrictions, ecological concerns, and soil sustainability have begun to call the practice into question. Growers are now faced with a dilemma: Fumigation has been an easy solution to many causes of decreased crop yields, but what options are available that are as effective to protect yield yet still responsible when it comes to health, safety, and environmental impact?

This article highlights sustainable alternatives to soil fumigation, including the combination use of two specific Huma Gro® products, Promax® and Zap®, that provide effective nematicide/fungicide actions while building a vigorous soil biology for the natural improvement of soil health and fertility—and increasing strawberry yields.

Soil fumigation has been routinely used on sensitive annual crops such as strawberries, carrots, bell peppers, tomatoes, cantaloupes, and potatoes since the 1960s. Soil fumigant products are typically applied in the fall after harvest or in the spring as a pre-plant soil preparation. The process involves having trained/certified operators inject a gas—usually with an active ingredient of chloropicrin; dazomet; 1,3-dichloropropene; metam sodium; metam potassium; and/or methyl bromide—into crop soil that is then often covered with a tarp to prevent the gas from escaping into the atmosphere. As this gas works its way through the soil it kills most of the soil microbiology, including organisms such as nematodes and various soil-disease pathogens, as well as some weed seeds.


http://ucce.ucdavis.edu/files/repository/calag/img6703p186.jpg

Over the years, the U.S. Environmental Protection Agency (EPA) has implemented increasingly stringent restrictions on soil fumigation to protect the health of farm workers and the populations of nearby communities. These restrictions include requiring protective clothing and breathing protection for fumigant handlers and applicators; creating buffer zones around fumigated fields to protect occupants of nearby homes, schools, and businesses from drifting poison fumes; and establishing safe re-entry intervals for when farm workers can come back into the fumigated fields. Immediate symptoms of fumigant exposure can include burning eyes, nausea, headaches, asthma attacks, and throat irritation. Long-term exposure to soil fumigants—including through groundwater contamination—can possibly lead to cancer, reproductive harm, and developmental delays in children, among other claimed side effects.

In addition to EPA restrictions due to health concerns, the widely used fumigant ingredient methyl bromide has been singled out as an ozone-depleting chemical. The Montreal Protocol, an international treaty signed by the United States, required that methyl bromide be completely phased out as an agricultural pesticide by 2005. The deadline was later extended to 2015, but it did not go into full effect until 2017.

With methyl bromide no longer an option, strawberry growers have moved to fumigation options that include combinations of chloropicrin (a toxic air contaminant that has mandated buffer zones, waiting periods for tarp removal, and monitoring requirements), 1,3-dichloropropene, and metam sodium. One commonly used combination product has a label that includes 45 pages of regulations, use restrictions, and safety precautions.

Because these chemicals are less volatile than methyl bromide, they can be applied through drip irrigations systems—an approach used on over 55% of California strawberry acreage. Applying the chemicals via irrigation eliminates the need for workers to be out in the fields while the chemicals are being applied, but it does require more specific soil preparation and application management to ensure thorough coverage. There is also the risk that the chemicals can damage irrigation PVC pipe if not thoroughly flushed after application.

Strawberry growers are willing to go through this complicated and dangerous process because of the promise of greater yields, and it is easy to understand why. Strawberry growers saw their yields nearly quadruple in the decades after fumigants were first used. Many growers attributed this tremendous yield success to fumigant use, and they remain convinced that they cannot achieve commercially competitive yields without it.

Advances in Understanding Soil Microbiology

In addition to the long-known negative health effects of soil fumigants on humans and other living things, more recent developments in the understanding of the importance of biodiversity in crop soil has led many to believe that the use of soil fumigants damages nutrient cycling and the long-term sustainability of soil fertility. Fumigants kill almost everything in the soil, including the beneficial bacteria, fungi, and other micro- and macro-organisms that keep the soil healthy and fertile. In recent years, soil scientists have developed a much better understanding of the plant-microbial interaction: in exchange for what they want, some soil microorganisms break down nutrients and provide them to plants in a form that the plants can easily use; others help protect plants from many types of diseases and predators, as well as create a soil structure that is beneficial to the absorption and flow of necessary oxygen, carbon dioxide, and water—improving plant respiration and hydration.

When soil fumigants sterilize the soil, they not only kill off all the beneficial microorganisms, they also set up conditions that make the soil and crops more vulnerable to future pest invasions. In healthy soils, biodiversity helps to control

damaging pests by giving them competitors that "out-eat" and "out-survive" them—a process referred to as "competitive exclusion." When the good competitors are killed off in fumigation, the door is left wide open for the damaging pests to come back stronger than ever; hence, the need for year-after-year fumigation applications. Also, without the beneficial microorganisms being available in sufficient numbers to provide nutrients to plants in a form that they can easily consume, growers are forced to increase the amount of fertilizers they use to sustain previous yield levels—increasing inputs but decreasing productivity.

Despite the concerted effort to eliminate disease, strawberry pathogens have continued to evolve. In the past decade or so California has seen a devastating rise in two soil-borne fungi pathogens that were previously not problematic for strawberry growers: *Macrophomina phaseolina* and *Fusarium oxysporum* f. sp. *fragariae*. (More about these two later.)

Sustainable Alternatives

Soil fumigants have been tantalizingly easy for growers to use because one application process has so many good immediate outcomes—such as weed control, nematode control, disease suppression, etc. So, with fewer effective soil fumigants available and costs rising to meet the restrictions associated with fumigant application and use, what alternatives do responsible growers have if they want to grow premium crops in a cost-effective *and* sustainable way? They begin by providing sound soil stewardship that puts the soil microorganism ecology, or "microbiome," back in balance.

To do this and replace fumigants, it is likely going to require multiple practices that may change as individual crop-growing circumstances change. Some of these practices include:

- **Using Disease-/Pest-Resistant Varieties of Cultivars:** These are available for some crops but not for others. We expect them to become more available in the future, so growers should always be on the lookout.
- **Green Manures/Crop Rotation:** For fields that are not in continuous strawberry production, certain cover crops (e.g., winter rye/hairy vetch mix) that are incorporated into the soil before they reach maturity have proven effective in managing specific pests. The simple act of "growing something besides strawberries" in the soil makes it more difficult for strawberry-specific pathogens to take hold in the soil. The addition of organic matter into the soil in general has a positive effect on yield in its own right.
- **Soil Solarization:** Placing plastic sheets over moist soil during periods of high temperature can kill many disease-causing organisms, nematodes, and weed seeds; however, this practice is most effective only in hot, dry climates and may have damaging effects on beneficial microbes as well.
- **Using Less Harsh or Natural Nematicides/Fungicides:** Sometimes all that is needed is an effective organic or natural nematicide/fungicide, particularly when paired with some of the other practices outlined above.

The Huma Gro® Alternative to Fumigation That Increases Strawberry Yields

That last practice area mentioned above is where Huma Gro® can help, with its combination of **Promax**® (an OMRI-Listed, broad-spectrum, organic soil fungicide/nematicide) followed by **Zap**® (formulated to feed the native beneficial soil microbiology, creating biological balance and diversity). The goal is to use **Promax**® to knock down the unbalanced microbiome, then use **Zap**® to build up a more balanced and diverse microbiome.

With **Promax**®, being an organic product in no way diminishes its effectiveness. Increased grower usage backed by years of field trials and university-based research reports testify to how well it works against many types of soil-borne diseases and plant parasitic nematodes. (See the list on page 12 of this publication; see specific product details on pages 12 and 13; view reports and testimonials at https://humagro.com/case-studies.)

Along with its effectiveness, the **Promax**®-followed-by-**Zap**® application offers many advantages when compared with fumigants:

- **Zero Buffer Zone: Promax**®, because its active ingredient is a natural plant oil that is not toxic to plants or humans, has a zero buffer zone and can be applied anywhere without restrictions.
- **Zero Re-Entry Interval: Promax**® has a zero re-entry interval, meaning that you can spray and walk right into the field. **Promax**® can also be applied anytime throughout the growing season without harming the plants or damaging plant roots.
- **Zero Residue:** With its active ingredient of thyme oil, **Promax**® can be applied up to the day of harvest and still be safe. Also, **Promax**® will not pollute the waterways or destroy the ozone.
- **Ease of Application: Promax**® can be applied through an irrigation/fertigation system and will not clog emitters.
- **Reapplication Friendly:** Nematode eggs are often buried deep in the soil, and a new wave can emerge weeks after any type of treatment. With **Promax**®, you can do another application whenever it is needed without all the fuss, expense, and risk associated with harsher products or fumigants. This ability to apply whenever it is needed can save crops and preserve yields that might otherwise be lost if a grower is reliant on fumigant technology that can only be applied when there are no crops in the field.
- **Prevents Resistance:** The technology behind **Promax**® is 100% natural, which prevents soil organisms from developing resistance and allows **Promax**® to continue to be effective even after multiple applications.
- **A Plan for Sustainable Soil:** Huma Gro® **Promax**® followed up with **Zap**® helps restore a healthy microbial balance for soil sustainability and fertility. Growers who look beyond the current crop understand the importance of long-term soil sustainability for future crops. Huma Gro® offers an effective and responsible approach, whereas fumigants are only concerned with sterilizing the soil.

Lab Report: Promax® Effectiveness on Strawberry Pathogens

Plant Sciences, Inc. conducted an *in vitro* bio-assay testing of **Promax®** efficacy in controlling strawberry pathogens (*see full report pp. 9–11*). **Promax®** was tested on the following 8 fungi and fungal-like strawberry pathogens:

- *Botrytis cinerea*
- *Colletotrichum acutatum*
- *Cylindrocarpon destructans*
- *Fusarium oxysporum* f. sp. *fragariae*
- *Macrophomina phaseolina*
- *Phytophthora ramorum*
- *Rhizoctonia solani*
- *Verticillium dahliae*

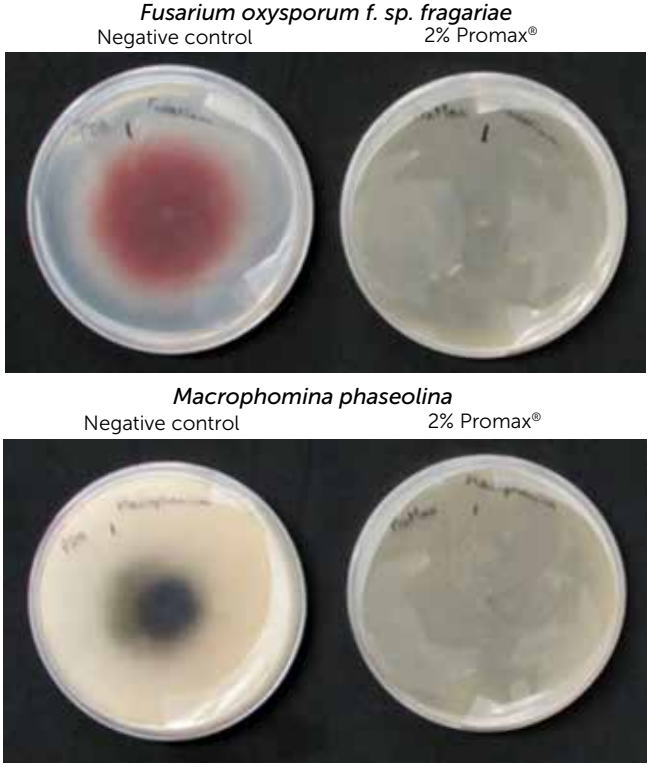

Figure 1. Photographs of 2 control and Promax®-treated strawberry pathogen cultures after 1-week incubation.

[Note the newcomers *Fusarium oxysporum* f. sp. *fragariae* and *Macrophomina phaseolina* mentioned earlier in this article.] **Promax®** was found to be highly effective in *in vitro* control of these 8 strawberry pathogens. The photographs in Figure 1. were taken after 1 week of incubation time at 20°C. Figure 2 shows growth inhibition at 1 and 2 weeks after **Promax®** application.

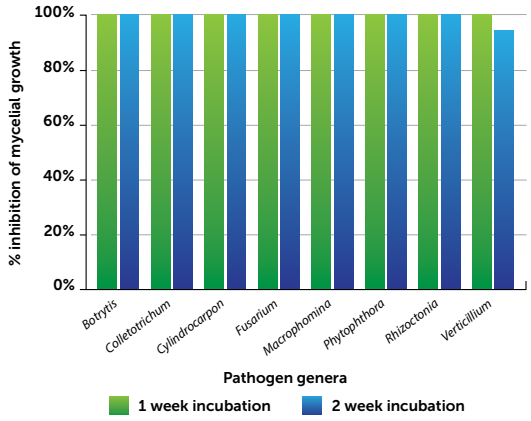

Figure 2. Percentage inhibition of mycelial growth of 8 strawberry pathogens *in vitro* using agar-based media amended with 2% Promax®

Maintaining a Healthy Soil for Better Strawberry Production

- Repeated monocropping in the same field, as is usually the case with strawberry production, guarantees that strawberry-loving soil-borne pathogens will take up residence and proliferate.
- Soil fumigation has traditionally been used in an attempt to rid strawberry fields of pathogens that damage crops and lower yields, but there is no such thing as fumigation that kills only strawberry pathogens: fumigation kills everything—including beneficial microorganisms that the plants need for their health and nutrition.
- Without a healthy community of soil microorganisms (the microbiome,) strawberry plants will not reach their full yield potential.
- A healthy microbiome requires balanced diversity to make sure that pathogens can't gain enough of a foothold to damage a crop.
- Once pathogens get established to the point that they are damaging crops, the pesticide selected should be strong enough to do the job, gentle enough not to harm the environment or the plants and humans in the environment, and natural enough to make it difficult for pathogens to develop resistance.
- Any time a soil pesticide is used, it is especially important to take active steps to build back a healthy, balanced, diverse soil microbiome that will keep pathogens at bay while still providing needed biological support to the plants and soil.
- Successful farming of strawberry crops includes active husbandry of the soil biology. Failure to do so creates an endless cycle of more pesticides, more fertilizers, and lower, less nutritious yields.

Case Study: Promax®/Zap® as an Alternative to Soil Fumigation

Pacific Ag Research conducted a Huma Gro® fumigant replacement trial in which our Huma Gro® **Promax®/Zap®** combination went head to head against PicClor pre-plant fumigation (see full report on pp. 7–8). **Promax®** was applied to the soil with irrigation at preplant and then 5 additional times throughout the season. **Zap®** was irrigation-applied 1 week after each **Promax®** application in order to help rebuild the soil microbiome with more robust, diverse microbial populations to compete with the pathogens.

Yields (seen in Figure 3) with the **Promax®/Zap®** combination (Treatments 1 and 4) were much higher than in the fumigated fields (Treatments 2 and 3). In fact, the yields for the **Promax®/Zap®** combination applied with our Huma Gro® Precision Blend™ nutrients were over 11,000 lb/ac higher than the fumigated field that had a grower's standard nutrient program.

In addition, the study was able to show (Figure 4) that for the two trials that used preplant field fumigation (Trial 2 and Trial 3), weekly yields began dropping off at week 11/6, while the trials that replaced preplant field fumigation with periodic applications of **Promax®** and **Zap®** (Trial 1 and Trial 4) continued to produce at relatively high levels until the end of the season.

Conclusions

Pre-plant fumigation of strawberry fields is an unsafe and outdated practice that growers now have many reasons to stop using. One of the biggest reasons is that it no longer makes economic or agronomic sense, given the cost-effective Huma Gro® **Promax®/Zap®** alternative that

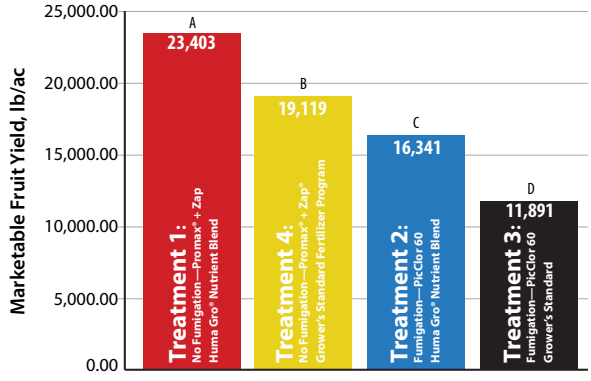

Figure 3. Total Marketable Strawberry Yield lb/ac, by Treatment

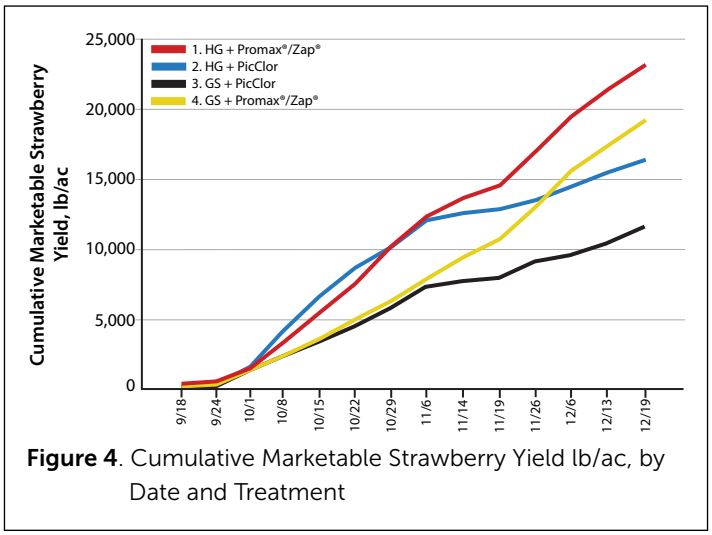

Figure 4. Cumulative Marketable Strawberry Yield lb/ac, by Date and Treatment

is more safe for the environment, better for the soil and its microbiome, less likely to lead to pathogens developing resistance, and more likely to increase yields. Using Huma Gro® **Promax®/Zap®** to control soil pathogens in strawberry fields is an effective and responsible approach that allows growers to be commercially competitive.

For more information or a free consultation:

Contact Huma Gro® at https://humagro.com/strawberries **or call 1-800-961-1220.**

To view the entire Huma Gro® product catalog online, go to http://bit.ly/HG-Catalog-2018.

Resources

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Additional Huma Gro® Strawberry Reports:

- Huma Gro® Program Increases Strawberry Yields 14%, With an ROI > $2,500/acre: https://humagro.com/wp-content/uploads/2019/01/Huma-Gro-Program-Increases-Strawberry-Yields-14-Field-Trial-Holden-2-HG-ENG.pdf
- Huma Gro® Program Increases Marketable Strawberry Yields 19%, With an ROI > $5,000/acre: https://humagro.com/wp-content/uploads/2018/03/Huma-Gro-Program-Increases-Strawberry-Yields-19-Field-Trial-HG.pdf
- Huma Gro® Program Increases Strawberry Yields 13%, With an ROI > $3,400/acre: https://humagro.com/wp-content/uploads/2017/04/Huma-Gro-Program-Increases-Strawberry-Yields-Field-Trial.pdf

Appendices

Huma Gro® Nutrient and Fumigation Replacement Program Increases Strawberry Yields

Field Trial

Conducted by: Pacific Ag Research
Huma Gro® Products: Ultra-Precision™ Blend (Fresca CA Strawberry Mix), Promax®, and Zap®

Objective

This field trial assessed the effects on strawberry yields of replacing field fumigation with periodic applications of Huma Gro® Promax® and Zap® and replacing a grower's standard fertilizer program with irrigation-applied Ultra-Precision™ blended liquid Huma Gro® crop nutrition products.

Materials & Methods

This trial was conducted in Arroyo Grande, Calif., using Portola strawberries planted in 40' x 3.33' plots. There were 4 treatment programs studied, set up in a randomized-block design replicated 6 times. The strawberries were planted on June 30 and harvested weekly from Sept. 18 through Dec. 19.

The four trial programs compared pre-plant fumigation (PicClor 60) with periodic applications of Huma Gro® Promax® and Huma Gro® Zap®. It also compared a Grower's Standard fertilizer program with a pre-mixed Ultra-Precision™ blended liquid fertilizer program of Huma Gro® products (Fresca CA Strawberry Mix Ultra-Precision™ Blend) selected specifically for strawberries and applied through drip irrigation.

The Grower's Standard fertilizer program included the following: 18-6-12 Osmocote Slow Release, 600 lb/ac, applied 1x; CAN 17, 10 gal/ac, 4x; 7-7-7, 20 gal/ac, 2x; Calcium nitrate, 10 lb,ac, 8x; Multi K (13-0-46), 10 lb/ac, 8x; Microplex, 1 lb/ac, 8x; Monterey Maxi (6-30-30), 10 lb/ac, 3x; and 20-20-20, 10 lb/ac, 3x.

The 4 trial programs were as follows:

1. • *No fumigation*—**Promax®** at 2 gal/ac, soil-applied preplant and 5 additional times during the season. **Zap®** at 1 gal/ac applied 1 week after each Promax® application.
   • Huma Gro® **Ultra-Precision™ Blend** at 5.32 gal/ac irrigation-applied twice a week for 22 weeks beginning July 6 until final harvest.
2. • *Fumigation*—PicClor 60 at 25 gal/ac applied once 3 weeks prior to planting
   • Huma Gro® **Ultra-Precision Blend** at 5.32 gal/ac irrigation-applied twice a week for 22 weeks beginning July 6 until final harvest.
3. • *Fumigation*—PicClor 60 at 25 gal/ac applied once 3 weeks prior to planting
   • Grower's Standard fertilizer program
4. • *No fumigation*—**Promax®** at 2 gal/ac, soil-applied preplant and 5 additional times during the season. **Zap®** at 1 gal/ac applied 1 week after each Promax® application.
   • Grower's Standard fertilizer program

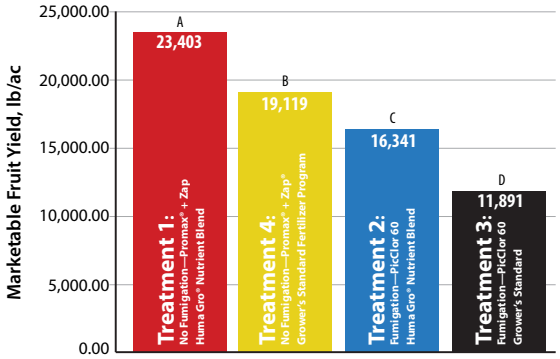

Figure 1. Total Marketable Strawberry Yield lb/ac, by Treatment

The strawberries were picked 14 times during the growing season, and measurements were made at each picking and results calculated cumulatively of trays picked per acre, marketable utilization of berries, yield (by weight), and price paid per yield.

Results

As can be seen in ***Figure 1***, Treatment 1 (all Huma Gro®, no fumigation) produced the highest marketable yield (23,403 lb/ac) when compared with the control, Treatment 3 (fumigation plus grower's standard fertilizer program, with a yield of 11,891 lb/ac). Treatment 4 had the second highest marketable yield in the trial (19,119 lb/ac), also using the Huma Gro® fumigation replacement of Promax® and Zap® but using the Grower's Standard fertilizer program. (See page 2 for additional results.)

Conclusions

This trial and others demonstrate that ***the use of Huma Gro® Promax® and Zap® can achieve high yields on Portola strawberries in California, even without traditional fumigation***. Treatments with Promax® and Zap®, which were applied via irrigation, have the advantage over traditional fumigation in that they are nontoxic, have no reentry interval, and could be applied at any time during the growing season. This is a tremendous advantage over traditional fumigation.

This trial also demonstrates that the Huma Gro® Ultra-Precision™ blend of liquid fertilizers applied through irrigation resulted in yields superior to the grower's standard fertilizer program. The combination of Huma Gro® Ultra-Precision™ blend of liquid fertilizers plus the Huma Gro® fumigation replacement products of Promax® and Zap® (Treatment 1) ***increased yields by over 11,000 lb/ac compared with the control*** (Treatment 3).

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Page 2: Supplemental Data

Additional Results and Conclusions

Treatment 1—which had the highest yields—was also all applied via irrigation, making it ***the easiest treatment of the four to apply.***

Figure 2 and ***Table 1*** demonstrate that for the two trials that used PicClor preplant field fumigation (Trial 2 and Trial 3), weekly yields began dropping off at week 11/6, while the trials that replaced preplant field fumigation with periodic applications of Promax® and Zap® (Trial 1 and Trial 4) continued to produce at relatively high levels until the end of the season.

About Ultra-Precision™ Blending

Ultra-Precision™ Blending is a service provided by Bio Huma Netics, Inc., to create custom crop nutrition and protection blends—from our line of over 70 liquid Huma Gro® or Fertilgold® Organics products—that are unique to grower, location, crop, and crop stage.

Ultra-Precision™ Blending formulations are created using grower data collected from plant sap or tissue analysis to meet specific, immediate crop needs. These blends are shipped to the grower ready for application through any established fertigation system (flood, furrow, pivot, drip, foliar, etc.). No on-site mixing or special application equipment are required. These custom blends include our proprietary Micro Carbon Technology®, a nutrient carrier designed to provide highly effective nutrient uptake.

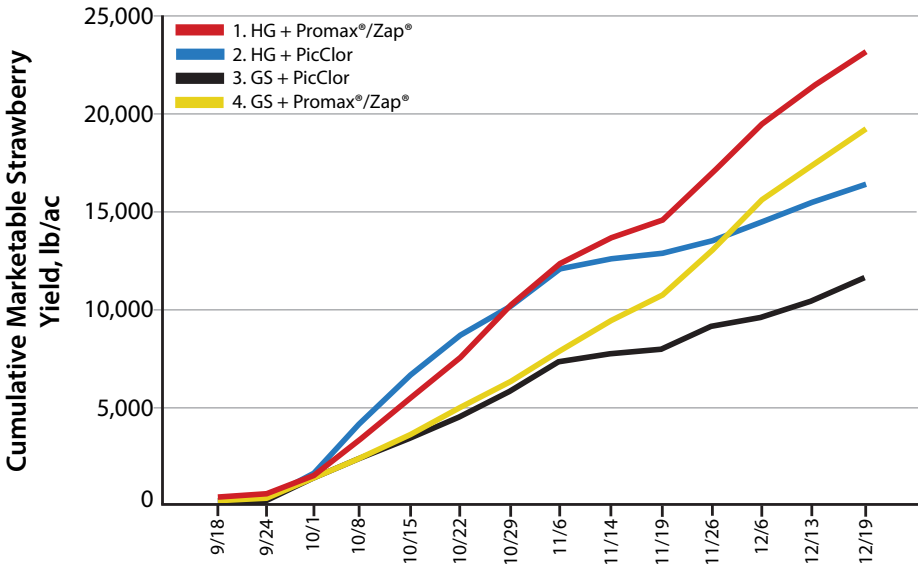


Figure 2. Cumulative Marketable Strawberry Yield lb/ac, by Date and Treatment

Table 1. Pounds/Acre Harvested Marketable Strawberries by Date and Treatment Group

Treatment	Pounds/Acre Harvested by Date													
	9/18	9/24	10/1	10/8	10/15	10/22	10/29	11/6	11/14	11/19	11/26	12/6	12/13	12/19
1. HG + Promax®, Zap®	177.8	290.8	921.6	1,851.7	2,319.1	2,219.4	2,321.5	2,129.3	1,499.6	1,100.7	2,286.7	2,617.2	1,754.4	1,913.0
2. HG + PicClor	141.8	243.9	1,163.2	2,626.8	2,563.1	2,037.9	1,762.8	1,479.2	523.9	325.6	699.3	966.1	915.6	891.6
3. GS + PicClo	106.9	334.1	788.3	1,405.9	902.4	1,192.0	1,195.6	1,574.1	516.7	361.7	1,032.2	443.4	883.2	1,154.8
4. GS + Promax®, Zap®	193.5	266.8	662.1	1,234.1	1,344.6	1,151.2	1,437.2	1,623.4	1,535.7	1,355.4	2,319.1	2,677.2	1,457.6	1,861.3

In Vitro Bio-Assay Testing of PROMAX® Efficacy in Controlling Strawberry Pathogens

Laboratory Report

Plant Sciences, Inc.

Objective

Test the efficacy of Promax® for inhibiting mycelial growth of 8 fungal strawberry pathogens through *in vitro* bio-assay.

Methods

Potato dextrose agar was amended with Promax® at a rate of 2% after autoclaving and cooling to 55°C on a stir plate. The amended media was poured into Petri plates and, once cooled and solidified, they were inoculated with 8 economically important strawberry pathogens (*see list, next column*). Plates were inoculated by placing a 5 mm mycelial agar plug, taken from actively growing culture, onto the center of the amended media. Non-amended agar plates were also inoculated as a negative control treatment. For each treatment by pathogen combination, three replicate plates were inoculated. The plates were incubated at 20°C for 2 weeks. The diameter of each mycelial colony was measured weekly. The % inhibition by the test chemical was calculated using the difference between the mean of replicates in the negative control group and the treated group.

The following 8 fungi and fungal-like pathogens were tested:

- *Botrytis cinerea*
- *Colletotrichum acutatum*
- *Cylindrocarpon destructans*
- *Fusarium oxysporum f. sp. fragariae*
- *Macrophomina phaseolina*
- *Phytophthora ramorum*
- *Rhizoctonia solani*
- *Verticillium dahliae*

Results

After 1 week of incubation, all 8 pathogens tested were completely inhibited from mycelial growth in media amended with 2% Promax® (*see photos, pages 2 and 3*). After 2 weeks, 7 of the 8 pathogens were still 100% inhibited. *Verticillium dahliae* began to grow a little after 2 weeks; the mean percentage inhibition of *V. dahliae* was 94% after 2 weeks (*Figure 1*).

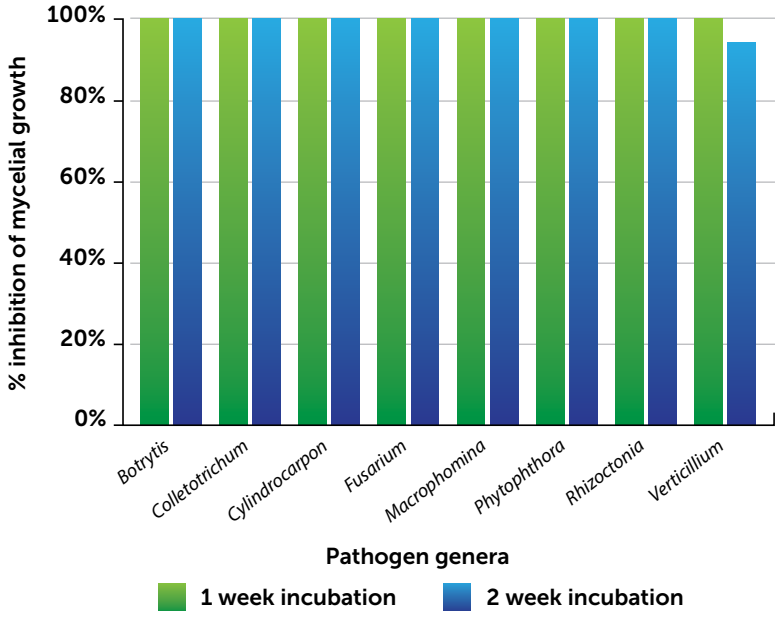
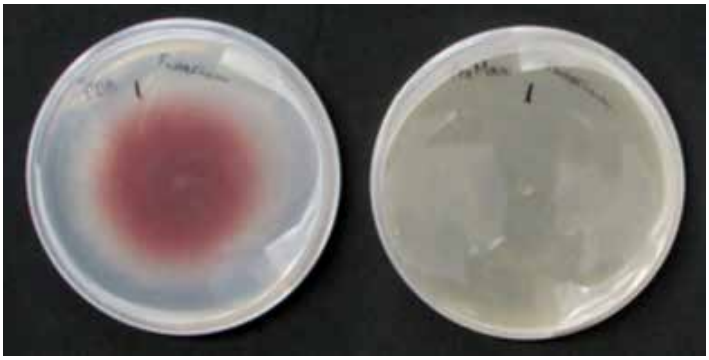


Figure 1. % Inhibition of Mycelial Growth of 8 Strawberry Pathogens *In Vitro* Using Agar-Based Media Amended With 2% Promax®

The following photographs were taken after 1 week of incubation time at 20°C
(by 2 weeks some pathogens had reached the edge of the plates).

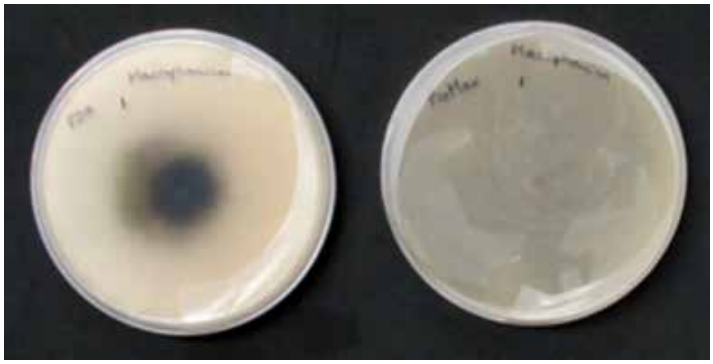
Fusarium oxysporum f. sp. fragariae

Negative control 2% Promax®



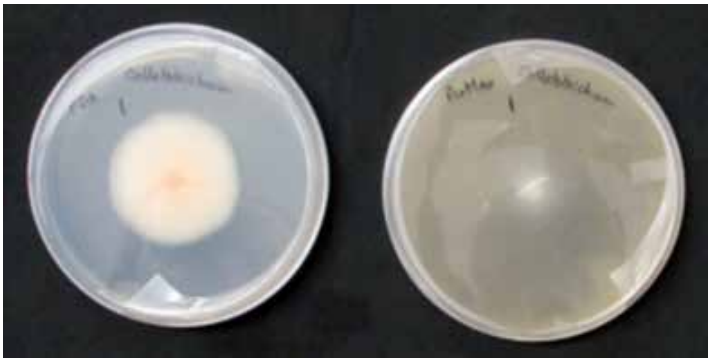
Macrophomina phaseolina

Negative control 2% Promax®



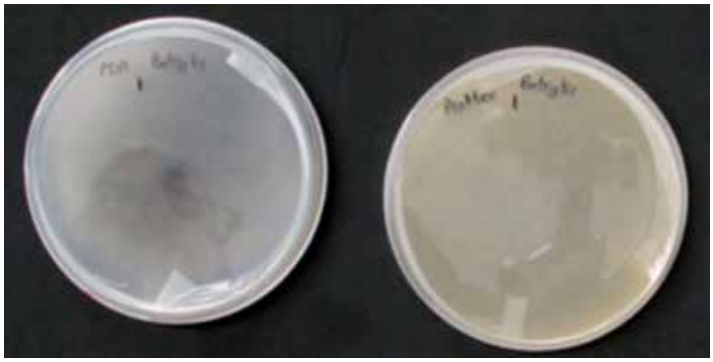
Colletotrichum acutatum

Negative control 2% Promax®



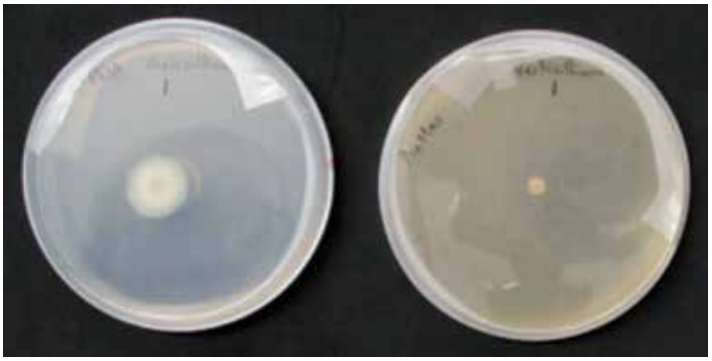
Botrytis cinerea

Negative control 2% Promax®



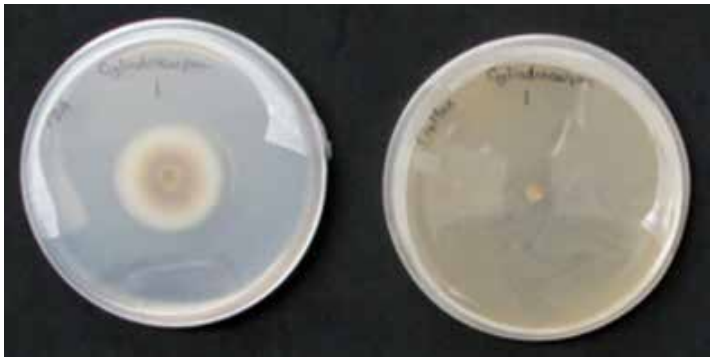
Verticillium dahliae

Negative control 2% Promax®



Cylindrocarpon destructans

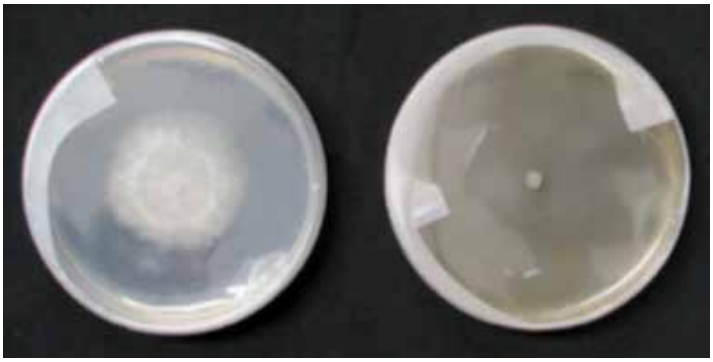
Negative control 2% Promax®



In Vitro Bio-Assay Testing of PROMAX® Efficacy in Controlling Strawberry Pathogens

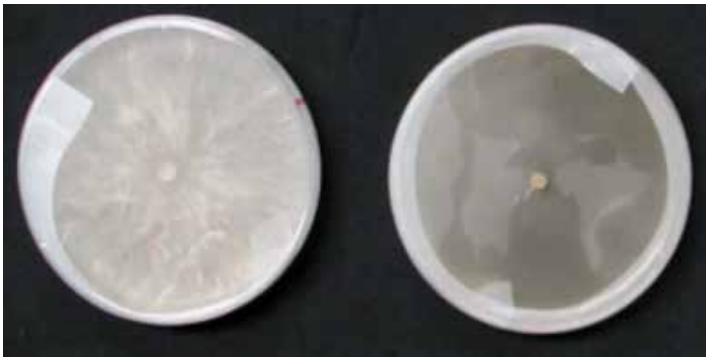
Phytophthora cactorum

Negative control | 2% Promax®



Rhizoctonia solani

Negative control | 2% Promax®



Conclusions

Promax® was highly effective in *in vitro* control of these 8 strawberry pathogens.

For more information on Promax®, go to www.promaxprotect.com.

For more information on other Huma Gro® products, go to www.humagro.com.

Huma Gro® research reports, field studies, and testimonials may be found at https://humagro.com/case-studies/.

The Huma Gro® *Product Catalog* may be viewed at http://bit.ly/HG-Catalog-2018.

PROMAX®

Zero-Residue Crop Protector

Guaranteed Analysis

Active Ingredients:

Thyme Oil	3.5%
Inert Ingredients*	96.5%
Total Ingredients	100.0%

**Contains water, molasses, glycerin*

Physical Properties:

Form: Liquid
Appearance: Hazy to opaque, brownish, having a unique characteristic odor.
Weight: 9.0 lb/gal, 1.00 kg/L
pH: 5.0–6.0

Caution:

Keep out of reach of children.
Harmful if swallowed. Exposure to this product's mists or liquid may cause severe irritation to the eyes and may cause irritation to the skin and respiratory tract.

Storage and Handling Precautions:

Store in a cool, dry, well-ventilated area, away from incompatible materials and products. To protect eyes and skin from contact with this product, applicators and other handlers must wear a long-sleeved shirt, long pants, shoes and socks, protective eye wear, and chemical-resistant gloves made of neoprene, nitrile, or natural rubber. Avoid breathing vapors, aerosols, or mists. Use with adequate ventilation. Keep the container tightly closed when not in use. Wash thoroughly with soap and water after handling this product.

Disposal Considerations:

If this product is disposed of as shipped, it does not meet the criteria of a hazardous waste as defined under 40 CFR 261, in that it does not exhibit the characteristics of a hazardous waste of Subpart C, nor is it listed as a hazardous waste under Subpart D due to toxicity. As a non-hazardous liquid waste, it should be disposed of in accordance with all local, state, and federal regulations. Consult state or local officials for proper disposal method.

Conditions of Sale:

The information contained in this bulletin is believed to be accurate and reliable. Buyer and user acknowledge and assume all liability resulting from the use of this material. Follow directions carefully. Timing, method of application, weather, and other factors are beyond the control of the seller.

OMRI LISTED For Organic Use

Minimum Risk Pesticide
EPA FIFRA 25(b) Exempt Product Registration

Broad-Spectrum Soil Fungicide and Nematicide

Huma Gro® PROMAX® is an organic-listed, EPA-exempt crop protection product. It is a protective and curative pesticide recommended for control of plant parasitic nematodes and soil-borne diseases. The mode of action is as a contact killer. There is no restricted use, so it can be applied throughout the entire growing season.

Integrated Pest Management:

PROMAX® is formulated to deliver maximum performance while minimizing residual effects. PROMAX® is compatible with most insecticides, miticides, fungicides, herbicides and fertilizers; therefore, it is considered as an ideal product in tank mix strategies and in rotation programs.

Plant Parasitic Nematodes and Crops *(including, but not limited to)*	
Burrowing (*Rodopholus*)	Tree fruits (bearing and nonbearing): apples, cherries, citrus, peaches, pears
Lance (*Hoplolaimus*)	Cotton, turf grass
Lesion (*Pratylenchus*)	Carrots; cucurbits (cucumber and melons); potatoes; sweetcorn; tree fruits (bearing and nonbearing), citrus, peaches; turf grass
Reniform (*Rotylenchulus*)	Cotton, tomatoes, tree fruits
Ring (*Circonemoides*)	Cucurbits, peppers, potatoes, tomatoes, turf grass
Root-knot (*Meloidogyne*)	Carrots, cotton, cucurbits, onions, peppers, potatoes, tomatoes, tree fruits (bearing and nonbearing), citrus, turf grass
Soybean Cyst (*Heterodera*)	Soybean
Spiral (*Helicotylenchus* and *Rotylenchus*)	Carrots, sweet corn, sweet potatoes, turf grass
Sting (*Belonolaimus*)	Carrots, cotton, cucurbits, peppers, potatoes, tomatoes, tree fruits (bearing and nonbearing), citrus, turf grass
Stunt (*Tylenchorhynchus*)	Carrots, cucurbits, onions, peppers, tomatoes, turf grass

Soil-Borne Diseases and Crops *(including, but not limited to)*	
Club Root (*Plasmodiophora brassicae*), **Black Rot**(*Xanthomonas campestris*)	Broccoli, Brussels sprouts, cabbage, cauliflowers
Anthracnose Fruit Rot (*Colletotrichum* sp.), **Charcoal Rot** (*Macrophomina* sp.), **Crown Rot** (*Fusarium* sp.), **Damping Off** (*Fusarium* sp., *Phytophthora* sp., *Pythium* sp., *Rhizoctonia* sp.), **Grey Mold** (*Botrytis* sp.), **Root Rot** (*Fusarium* sp., *Cylindrocarpon destructans*, *Pythium* sp., *Rhizoctonia* sp.), **Stem rot** (*Phytophtora* sp., *Sclerotium* sp.), **Verticillium Wilt** (*Verticillium* sp.)	Asparagus, beans, cole crops, cotton, cucurbits, eggplant, lettuce, onions, peas, peanuts, peppers, potatoes, nuts (almonds, walnuts), small fruits (strawberries, cranberries, raspberries), sweet potatoes, tobacco, tomatoes; tree fruits (bearing and nonbearing): apples, apricots, cherries, peaches, citrus, mangoes, pineapple, plums; turf grass, ornamentals and flowers (azalea, geranium, impatiens)
Stem Rot (*Sclerotium rolfsii*)	Peanuts, tomatoes, peppers
White Rot (*Sclerotium cepivorum*)	Garlic

For best results, 7–10 days after the final PROMAX® treatment is completed apply Huma Gro® ZAP® at 1 gal/acre (10 liters/hectare) for stimulation of the soil biological community.

Application Instructions:

- This product mixes readily with water. To prepare the spray mixture, fill the mix or spray tank with three-fourths of the required amount of water then add the proper amount of PROMAX®. Complete filling the mix or spray tank with the balance of water needed.
- It is important when using PROMAX® as a protective or a curative fungicide and nematicide that material be incorporated into the soil. This can be accomplished as a soil drench, mechanical incorporation, or as an in-furrow application watered in.
- Higher rates should be used as a curative, on heavy soils, in fields with a history of disease problems, or when weather conditions are expected to be favorable for rapid disease growth or nematode activity.
- Use a lower rate as a preventive or on light infestations.
- Repeat every 15 to 20 days for disease or nematode control as indicated on chart.
- Consult your local HUMA GRO® Representative for crop-specific recommendations.
- SHAKE WELL BEFORE USING. This product will separate. Constant tank agitation is required to ensure a homogeneous spray mixture.

METHOD OF APPLICATION	*SUGGESTED RATE PER ACRE/HECTARE*
Soil-banded, injected, side dress, drip tape, or micro sprinklers	Up to 1 gallon/acre, 10 liters/hectare
Soil broadcast spray incorporated	Up to 2 gallons/acre, 20 liters/hectare

ZAP®

Sustainable Soil Fertility

Guaranteed Analysis 8-0-0

Total Nitrogen (N) 8.00%
- 3.0% Ammoniacal Nitrogen
- 2.0% Nitrate Nitrogen
- 3.0% Urea Nitrogen

Sulfur (S) 1.00%
- 1.00% Combined Sulfur (S)

Iron (Fe) 0.10%
- 0.05% Chelated Iron (Fe)

Manganese (Mn) 0.05%
- 0.05% Chelated Manganese (Mn)

Zinc (Zn) 0.05%
- 0.05% Chelated Zinc (Zn)

Derived From:
Urea, Ammonium Sulfate, Ammonium Nitrate, Iron HEDTA, Manganese EDTA, and Zinc EDTA. (Chelating agents are Hydroxyethylenediaminetriacetate and Ethylenediaminetetraacetate.)

Also Contains Non-Plant Food Ingredient:
8.5% Organic Matter (derived from leonardite)

Physical Properties:
Form: Liquid
Appearance: Clear to hazy, brownish, having a unique characteristic odor.
Weight: 9.18 lb/gal, 1.00 kg/L
pH: 4.0–5.0

Caution:
Keep out of reach of children.
Harmful if swallowed. The liquid and mists may be irritating to the eyes and skin. Inhalation of mists may be irritating to the entire respiratory tract.

Storage and Disposal:
Keep product in original container. Do not transfer into food or drink containers. Triple rinse when empty for recycling. Always dispose of container in accordance with local, state, and/or federal regulations. Do not store this product below 50°F (10°C) or above 90°F (30°C).

Conditions of Sale:
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The Solution for a Strong, Healthy Soil

Huma Gro® ZAP® carbon-complexed with Micro Carbon Technology® is an organic-based formulation of nutrients for feeding the native beneficial soil microbial balance. ZAP® feeds a strong, vigorous soil biology, which indirectly results in the natural improvement of soil health.

How ZAP® Works:
- Effect on soil environment surrounding roots: ZAP® enhances activity of beneficial microbes detrimental to soil-borne diseases and plant-parasitic-nematodes.
- Effect on the plant: ZAP® improves root growth and, as a result, reduces susceptibility to secondary root infections.

Benefits of Use:
- Improved plant vigor
- Improvement in beneficial soil microbial activity
- Establishment of soil biological balance and species diversity
- Addresses microbial challenges related to cut- or leveled-ground soil infertility

Application Instructions:
See table below for specific rate instructions. Do not apply this product in concentrations greater than 10%. SHAKE WELL BEFORE USING.

METHOD OF APPLICATION	*SUGGESTED RATE* *Field Crops / Tree or Vine Crops*	
Soil banded, injected, side dress, drip tape, or micro sprinklers	Up to 1 gallon/acre, 10 liters/hectare	Up to 1 gallon/acre, 10 liters /hectare
Sprinklers: solid set, drag lines, linear, or pivot (100% speed)	Up to 2 gallons/acre, 20 liters/hectare	Up to 2 gallons/acre, 20 liters/hectare
Soil broadcast spray incorporated, flood or furrow irrigated	Up to 3 gallons/acre, 30 liters/hectare	Up to 3 gallons/acre, 30 liters/hectare

Powered by MICRO CARBON TECHNOLOGY

****This Product Contains Micro Carbon Technology® (MCT), a proprietary blend of very small organic molecules that allow for more effective absorption of nutrients by plants.***

1331 W. Houston Ave., Gilbert, AZ 85233

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