EM Fermented Plant Extract and EM5 for Controlling Pickleworm (*Diaphania nitidalis*) in Organic Cucumber

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Abstract

Diaphania nitidalis is a serious pest of cucumber and other vegetables of the *Cucurbitaceae* family. The conventional control of this pest calls for excessive use of chemicals which pollute both product and environment.

Field studies were undertaken in Costa Rica to develop integrated pest management programs for cucumber using EM plant extract in combination with EM5 with adequate controls for comparison. The incidence of disease and pest damage by the pickle worm was significantly lowered by foliar applications of EM fermented plant extract in combination with EM5. The potential use of EM for pest management while enhancing yields in cucumber is presented.

Introduction

Cucumbers are susceptible to many kinds of microbial pathogens and insects. In conventional farming systems, pesticides are used to combat them. However, these pesticides are contaminating our ecosystems and food products. Because of the polluting side-effects of pesticides and unsatisfied consumers, the organic agricultural industry is growing. These pesticides are not used in organic cultivation and therefore alternative forms of integrated pest management must be developed. Based on tests conducted in many different countries, there is evidence that the cultivation and application of beneficial microorganisms contained in EM can lower the incidence of these problems. The beneficial microorganisms contained in EM produce plant hormones, beneficial bio-active substances, and antioxidants while solubilizing nutrients. These metabolic byproducts of the beneficial microorganisms catalyze an energy shift within the ecosystem which creates a healthier environment for the plant. A healthier environment makes the plant healthier, more resistant to pathogenic disease, and less "attractive" to damaging insects while raising yields and lengthening the life of the plant. The high populations of beneficial microorganisms that occur in the system over time also competitively exclude the pathogenic microorganisms and nematodes. Certain microorganisms that can be found in healthy agricultural systems and EM create esters which deter insects. Therefore it is possible that by understanding the role of beneficial microorganisms they may be used to cultivate crops without the use of pesticides while achieving yields that are equal to or higher than those achieved with conventional methods.

The system described above, which has a high diversity and is very conducive to vigorous plant growth, can be found in any undisturbed virgin forest ecosystem. It can also be found in agricultural systems where the biological components of the soil have been adequately nourished and have not been overloaded with actively oxidizing substances like pesticides and agrochemicals. For those systems that have been damaged because of erosion, compaction, organic matter depletion, mineral depletion, and/or overloaded with active oxygen, the diversity and health of the system must be regenerated in order to organically cultivate crops with low incidence of disease, low incidence of insect damage, and high yields. This process of regeneration can be catalyzed and accelerated using inoculates of beneficial microorganisms applied in conjunction with organic matter. EM contains a high diversity of beneficial microorganisms including the antioxidizing and purification microorganisms known as phototrophic bacteria. These microorganisms lead the way in the regeneration and diversification of the ecosystem. The microbial ecology of EM is balanced in such a way that the species contained within can work in cooperation to dominate soil biological activity in a way that supports vigorous plant growth. After the process of regeneration has been catalyzed by the beneficial microorganisms and a system of soil nourishment has been established, EM is no longer needed as an inoculate because the entire system has become zymogenic synthetic.

From February to May, 1997, field trials of organic cucumber cultivation were carried out to determine the effects of foliar applications of EM-Fermented Plant Extract and EM5 on the incidence of insect damage and ultimately the yield of cucumbers. This paper reviews the experiment, recipes and results as they were carried out and obtained at the Integrated Farm of EARTH College in Costa Rica.

Materials and Methods

240 cucumber plants were organically grown in a randomized complete block design of 12 blocks. Each block was a raised bed 460 cm long, 120 cm wide, and 20 cm. High. There were 60 cm of paths between each bed. There were 15 plants in each block. Each bed received 21 kg of traditional compost and 3 kg of Anaerobic EM Banana Bokashi (Recipe Appendix) 14 days before seeding. All blocks received the same kind and quantity of irrigation.

There were three different types of foliar treatments (Recipe Appendix) and four replications of each treatment. Foliar treatments were applied in the same volume every four days:

Foliar Treatment #1: Use of well water

Foliar Treatment #2: Use of EM.F.P.E. diluted with well water (1 part EM F.P.E to 500 parts well water), alternating with well water.

Foliar Treatment #3: Use of EM F.P.E. diluted with wellwater (1 part EM-F.P.E. to 500 parts well water) alternating with EM5 diluted with well water (1 part EM-F.P.E. to 500 parts well water).

Results

After direct seeding and the emergence of the young plants, there was a noticeable difference among the growth rate between the control replications and those replications receiving EM-F.P.E., and EM-F.P.E. + EM5. The replications receiving only water grew slower and never got as large as the other replications. The replications receiving EM-F.P.E. and EM-F.P.E. + EM5 began developing flowers an average of 6 days before the replications receiving only water.

The plants from Treatment # 2 and Treatment # 3 grew very healthy without any sign of leaf blight or other pathogen diseases common to the humid tropic region until approximately the last 16 days of harvest. On the other hand the beds receiving Treatment # 1 grew healthy until about 22 days prior to the end of harvest before they began to develop leaf blight and their vigor began to decline.

Statistically speaking, Treatment #1 yielded significantly lower than the other two treatments. Treatment # 2 yielded second lowest and Treatment # 3 yielded the highest however, the difference in yields between Treatment #2 and Treatment #3 is not statistically significant (Table 1).

Table 1. Effect of Applications on Organic Cucumber Yields

Treatment	Average Yield of Cucumbers (g/m^2)	Average Number of Cucumbers Harvested ($\#/m^2$)	Average Weight of Cucumber (g./fruit)
Water	3,296.4 a	14.8 a	223.3 a
EM-F.P.E. + Water	4,416.9 b	18.8 b	235.6 b
EM-F.P.E. + EM5	4,860.3 b	20.9 b	232.8 b

Treatment means in a column sharing the same letter are not significantly different from each other according to Duncan's Multiple Range Test

The moth that causes pickle worm infection began coming shortly after the cucumber plants began to flower. However, the majority of the infections occurred in fruit of Treatment # 1 and the second largest amount of infections occurred in Treatment # 2.

When the cucumbers infected by the pickle worm are filtered, very significant differences in yields can be seen. About 80 percent of the fruit from Treatment #1, about 36 percent from Treatment #2 and about 9% from Treatment #3 were infected. Therefore it can be seen that the regular treatment of EM-F.P.E. alternating with EM5 was able to effectively control approximately 91 percent of pickle worm damage. On marketing, Treatment #3 has significantly higher yields because about 91% of the cucumber are not infected by the pickle worm (Table 2).

Table 2. Effect of Application on Pickle Worm Infection and Yields of Organic Cucumbers

Treatment	Percent of Yield Infected by Pickle Worm	Average Yield of Cucumbers not Infected by Pickle Worm (g./m^2)
Water	80 a	628.6 a
EM-F.P.E. + Water	36 b	2,799.6 b
EM-F.P.E. + EM5	9 c	4,414.9 c

Treatment means and percentages in a column sharing the same letter are not significantly different from each other according to Duncan's Multiple Range Test

Harvesting took place during the forty days from April 12th to May 21st. Every time cucumbers were harvested from Treatment #1 there were some infected with pickle worm. However for Treatment # 2 and Treatment # 3 there was a "window" of days during which no infections occurred. The window for Treatment # 2 was smallest with approximately 10 days, beginning April 29th. The window for Treatment # 3 was approximately 15 days, beginning April 24th.

Discussion and Conclusions

In terms of overall yields, the foliar application of beneficial microorganisms increased yields over those obtained from foliar applications of water. This is probably because of an increase in the health of the plants. The plants that were sprayed with EM-F.P.E. or with EM-F.P.E. + EM5 may have been healthier because of the inoculation of beneficial microorganisms. Based on the review of literature (References), the increased levels of beneficial microorganisms may have three main effects; increase in a wide range of plant available nutrients, repelling harmful insects, and higher levels of antioxidants. These three aspects can be seen as the result of an energy shift in the entire system that is catalyzed by the increased populations of beneficial microorganisms. This shift is a regenerative shift that occurs as the microbial diversity increases to a level that is closer to what was perhaps at one point the native microbial diversity of the soil. With higher diversity there is more stability and therefore a naturally healthy system that plants can thrive in.

The pickle worm infections were much greater in the replications that did not receive foliar applications of beneficial microorganisms. EM-F.P.E. + EM5 showed the best results by holding infections to only 9 percent and yields of cucumbers without infection reaching as high as 5.4 kg/square meter. This could result from the fact that with the application of EM5 and EM-F.P.E. the diversity of beneficial microorganisms is even greater than that of only applications of EM-F.P.E. This is because the process of fermentation and the materials used for EM-F.P.E. and EM5 are different and therefore incorporate a different ecology of microbes. Therefore when they are used in conjunction, rather than by themselves, the diversity is even greater. As stated earlier this increased diversity increases the stability of the system. EM5 also includes higher populations of species of lactic acid bacteria which create esters that deter insects by making a barrier of dislike between the insect and the plant. This repellent nature of EM5 plus the odors created by the EM-F.P.E. result in a much lower level of insect infection as seen in the results of pickle worm infection in this experiment.

These results will probably continue to improve for the next several plantings of cucumbers because the microbial diversity will continue to increase as long as harsh oxidizing chemicals like pesticides and chemical fertilizers are not added to the system. As a result it will become more balanced with higher levels of antioxidants which will help to support healthier cucumber plants. This will occur as the microbial ecosystem increases diversity with continued applications of EM-F.P.E, EM5, and EM Bokashi. Stabilization will also occur as a result of beneficial insect populations establishing themselves and exerting natural control of damaging insects.

Recipe Appendix

EM Anaerobic Banana Bokashi:

Materials:

Banana peels – approximately 80% moisture content (25% by volume)
Rejected seed yams – dried and chopped (25% by volume)
Arachis pintoi (Legume) – dried and chopped (25% by volume)
Rice husk (13% by volume)
Citrus rinds – chopped (6% by volume)
Corn meal (6% by volume)

Procedure:

Thoroughly mix the materials.
Dissolve molasses in water (1:100).
Add EM to the molasses-water solution (1:100).
Spray the EM-molasses-water solution on the materials while mixing.
Periodically check the moisture content while mixing.
When the moisture content has reached 30-40% do not add more solution.
Wrap the mixture to plastic or put in plastic bags to maintain an anaerobic condition.
Allow the mixture to ferment away from direct sunlight for 3-4 days.
When the bokashi has a sweet fermented smell, spread it on a concrete floor to dry.
When white mycelia can be seen covering the bokashi, it is ready for application.

Note:

Well water or rain water is recommended because treated water is usually chlorinated.
Other forms of sugar instead of molasses can be used, but the most unrefined is recommended.
30-40% moisture content can be determined by squeezing a handful of the mixture in your hand – when you open your fist the mixture should hold together without water dripping out.

EM-F.P.E.:

Plant Materials:

Citronella (20% by volume)
Eucalyptus leaves (20% by volume)
Citrus rinds (20% by volume)
Piperacea (20% by volume)
Weeds (20% by volume)

Solution Materials:

Water (94% by volume)
Molasses (3% by volume)
EM (3% by volume)

Procedure:

Chop all of the plant materials into small pieces (approx. 6-9 cm.).
Put chopped materials into a double-layered plastic trash bag in a bucket or drum.
Mix the solution materials together and add to the plastic bag with the plant materials.
Push as much air out of the plastic bag as possible.
Twist the opening of the plastic bags and tie shut so very little air can enter or escape.
Store the container with the materials out of direct sunlight during the fermentation.
For the next 3-5 days, gas will be generated by the fermentation processes.
When the pH of the solution is below 3.5, the EM-F.P.E. is ready.
Drain the liquid and store in a dark cool place until use.

Note:

The total volume of plant materials should be a little less than the total volume of liquid materials.
Well water or rain water is recommended because treated water is usually chlorinated.
Other forms of sugar instead of molasses can be used, but the most unrefined is recommended.

EM5:
Liquid Materials:
Water (60% by volume)
Molasses (10% by volume)
Natural Banana Vinegar (10% by volume)
Tequila : 40% Alcohol (10% by volume)
EM (10% by volume)

Plant Materials:
Garlic – chopped (33% by volume)
Chillie Pepper – chopped (33% by volume)
Flowers – chopped (33% by volume)
Procedure:
Use a bucket to dissolve the molasses in water.
Add the vinegar, alcohol, and EM to the molasses-water solution.
Mix well and put into a plastic container which can be shut tightly.
Add the chopped materials to the solution in the container.
Shut the container tightly for anaerobic fermentation.
As it is fermenting, release the gas that is generated, so the container does not explode.
When the pH of the solution is below 3.5 it is ready.
Drain the liquid and store in a dark cool place until use.
Note:
The total volume of plant materials should be about one tenth of the total volume of liquid materials.
Well water or rain water is recommended because treated water is usually chlorinated.
Other forms of sugar instead of molasses can be used, but the most unrefined is recommended.
Natural vinegar should always be used.
Whiskey or Ethyl alcohol (30-50%) can be used instead of tequila.

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