Organic Production I: Potted Poinsettia

Internal Report for Young Plant Research Center Partners.

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Executive Summary

A crop of 240 6-inch (15-cm) poinsettias were grown in 2004 by students based on organically-permitted methods. An acceptable crop was grown. This trial was a "proof of concept " showing that organic fertilization and pest control is possible with a long-term and challenging ornamental crop. Weaknesses in current organically-acceptable options include a lack of curative root disease and fungus gnat control products. Total direct production cost was $4.26 for an organic plant versus $1.26 for a conventionally-grown plant using the approach we took. Further research is needed to reliably control disease and fungus gnats, and to reduce costs. We will grow another crop following the national organic standards in 2005, and also we will try to propagate poinsettia cuttings organically (see following report).

Introduction

With the increasing interest in organic production methods, we evaluated the feasibility of organically producing a poinsettia crop. Why poinsettia? Although the market is not as great for ornamental potted plants as for food crops, each Fall growing season we grow a poinsettia crop in a sophomore level university course and so could dedicate the space and budget to the project. Because poinsettia is a long-term crop that has nutritional and pest management challenges, and demanding quality specifications, it provides a reasonable model greenhouse crop.

The organically-grown Freedom White and Red poinsettias at flowering.

Our objective was to evaluate whether we could successfully grow poinsettia to organic production standards. This report is <u>not</u> intended to suggest that UNH is an expert in organic greenhouse production, but we grew a good quality crop mostly relying on organically-acceptable methods (see exceptions below). The project provided an opportunity to evaluate challenges and feasibility.

There were at least four aspects of our crop production that did not meet the National Organic Program Standards, administered by the U.S. Dept. of Agriculture:

- The UNH research greenhouses are not certified organic production area. That would require that the land had no prohibited materials applied to it for three years immediately preceding harvest, and formal application for certification.
- We grew poinsettia conventionally in adjacent greenhouses, and it is prohibited to grow the same crops organically and conventionally in the same operation.
- The particular neem extract product we applied was not organically acceptable, but there are other neem products available that are listed by OMRI (the Organic Materials Review Institute, www.omri.org).
- Organically grown crops must normally be started from organically-certified seed or from stock plants that have been grown organically for one year – we started from conventionally-grown rooted cuttings in Oasis medium.

Management approach and results

180 Freedom Red and 60 Freedom White poinsettia rooted cuttings were planted on Aug. 9 2004 into 6-inch diameter, thick-walled azalea pots (one cutting/pot). Plants were pinched to 6 nodes on Sept. 9 and grown under long days until Sept. 29, for scheduled flowering on Nov. 24.

Monitoring. We monitored the crop intensively, taking an "integrated crop management" approach where different factors were monitored, compared against ideal ranges, and actions were taken to stay near our target range. Each week, we monitored media-pH and electroconductivity using a 1 soil:2 water soil test. We also monitored insect levels on sticky cards, measured plant height, and monitored light and temperature, and graphically tracked the data using UNH FloraTrack for Poinsettia software.

Media. We used Sun Gro Organic Growing Mix (OMRI-approved), which contains Canadian sphagnum peat (70-75%) and perlite (25-30%), dolomitic lime, a preplant charge made from organically-acceptable animal byproducts, and a yucca-based wetting agent.

Nutrition. Our nutrition program was based on the initial pre-plant charge from the Sun Gro medium, and supplementation with Omega 6-6-6 liquid fertilizer, which is made by microbial digestion of bloodmeal, bone meal & sulfate of potash. Plants were hand watered, and fertilizer was added (based on soil tests and class discussion) using an injector. We fertilized eight times during the crop with between 150 and 300 ppm of nitrogen. pH began high (7.3, compared with an ideal 5.6 to 6.4) but dropped to a low of 5.3 after 8 weeks and then remained between 5.4 and 6.2.

Media electroconductivity started low (0.3 mS/cm, with an ideal 0.4 to 1.2 mS/cm), increased to 1.3 mS/cm after 5 weeks, and remained in the acceptable range for most of the crop. For both of laboratory soil and media tests (Table 1), however, EC was high and there was excess nitrogen, phosphorus, and magnesium. Potassium and calcium levels were low in the tissue. Despite the fact that media and tissue levels were not ideal, plants looked nutritionally healthy throughout the crop.

Table 1. Media (top) and tissue (bottom) analyses in October and November for the poinsettia crop. High and Low levels represent limits of the normal range.

HIGH	6.4	3.5	180	20	35	300	200	100	100	3	3	3	0.5	0.5	0.5	3	100
LOW	5.5	1.0	35	0	5	35	50	25	5	0.3	0.15	0.3	0.050	0.050	0.01	0	0
SampleID	pH	E.C	NO3-N	NH4-N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B	Mo	Al	Na
Organic poinsettia Oct 11	***5.1***	**4.9**	**399**	**77.2**	**190**	**190**	**190**	**240**	**7.89**	***0.1***	**0.2**	***0.1***	***0.01***	***0.04***	***0***	**0.36**	**255**
Organic poinsettia Nov 5	***5.4***	**3.9**	**306**	**0.4**	**97**	**65**	**160**	**190**	***3.26***	***0.2***	***0.1***	***0.08***	***0.01***	***0.04***	***0***	**0.36**	**313**

HIGH	7	1.5	7.0	3.0	1.5	7500	250	200	150	25	100	10.00	100	200	3
LOW	4	0.5	3.5	1.0	0.5	2250	100	75	30	5	50	0.50	0	0	0.8
SampleID	%N	%P	%K	%Ca	%Mg	S	Fe	Mn	Zn	Cu	B	Mo	Al	Na	Fe/Mn ratio
Organic poinsettia Oct 11	**4.7**	**0.9**	***1.8***	***0.8***	**0.8**	2733.8	***90.4***	89.1	48.8	***3.8***	***22.0***	**18.3**	18.2	**0.0**	**1.0**
Organic poinsettia Nov 5	***4.0***	**1.0**	***1.8***	***1.0***	**0.8**	***1789.1***	***95.1***	122.6	47.5	***2.4***	***14.9***	**15.6**	19.1	**0.0**	**0.8**

Pest and disease management

Fungus gnats. Our only insect problem was fungus gnats. Fungus gnat larvae feed on plant roots, and can vector fungal diseases. At the peak in mid-October, fungus gnats reached 113 gnats per sticky card (both sides) in a week. The only effective way to reduce this number was with neem (azadirachtin) drenches. Students watered this crop from mid-September onward, which may have contributed to the fungus gnat problem. However, we emphasized good irrigation practices to the students, and plants were generally allowed to dry before watering. The medium would have benefited from additional perlite to enhance drying. In addition, we quantified fungus gnat levels in unused media using an incubation method that found an average of four fungus gnats per 6-inch pot. In our conventionally-grown plants in other greenhouses, synthetic insect-growth regulating drenches were highly effective for fungus gnat control. For fungus gnat control in the organic crop, we used

- A drench of *Bacillus thuringiensis* immediately after potting
- Release of *Hypoaspis miles* predatory mites every two weeks
- Drenches with *Steinernema feltiae* parasitic nematodes three times.
- Because we had high levels of fungus gnats despite these controls, we also drenched with neem extract once a week for three weeks near the beginning of the crop, and also three times near the end of the crop.


Fungus gnat adult on a sticky card

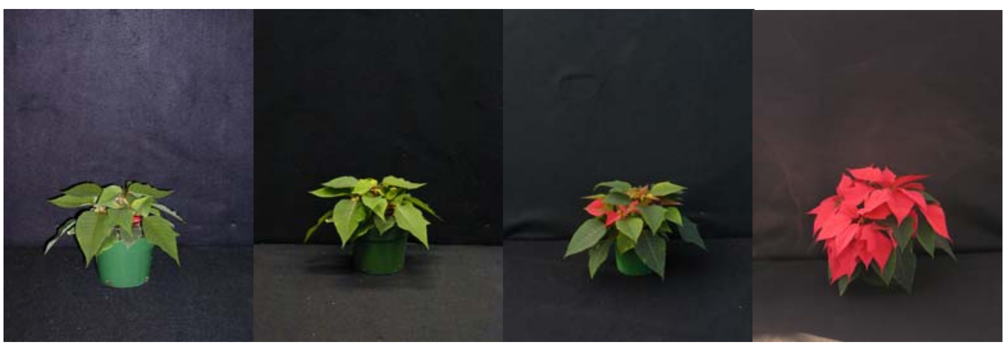
Whitefly. We release whitefly parasitic wasps (Eretmocerus eremicus) each week to parasitize silverleaf whitefly, and every two weeks we released Encarsia formosa, another parasitic wasp effective against greenhouse whitefly. No whitefly adults or pupae were observed in the crop.

Pythium. Our only disease problem occurred because there was pythium in a few of the Freedom Red cuttings when we received them, and high fungus gnat levels also encouraged pythium. We therefore lost 10% of the crop. We drenched with *Trichoderma harzianum*, a beneficial fungus, once each month for root disease control, however this is most effective as a preventative material. We also emphasized a high level of sanitation throughout the crop.


A plant lacking roots because of pythium

Overall plant quality

The crop looked healthy at flowering, and although plants were on the lower end of the target final height (14 to 16 inches tall), they were commercially acceptable. Flowering occurred on schedule.


Monthly change in plant appearance from September to November

Budget and Conclusions

The budget is shown in Table 2. This section goes down the budget, and discusses costs and observations from our crop.

A major challenge to growing an organic poinsettia or other vegetatively-propagated crop would be the requirement to produce the mother stock organically for one year – very difficult given the sensitivity of stock plants to pests and diseases (including viruses). Cost of organically-grown transplants were not available, but would probably be more expensive than conventionally-grown transplants.

Pest management blew our organic budget compared with conventional production. Our pest and disease management approach was based on advice from entomology and pathology experts. This was clearly a high-input approach, and for next season we should be able to reduce the cost and by (a) using neem drenches from the first three weeks if needed based on fungus gnat levels; (b) using *Encarsia formosa* unless silverleaf whitefly are observed, and thereby eliminating the Eretmocerus eremicus; and (c) eliminating the *Hypoaspis miles*. Because it did not provide adequate control and was expensive. Those changes would reduce our pest control costs by more than half. Entomologists tell us that one cannot rely on inundative releases of parasites, and that the two parasitic wasp species we used do not reproduce well on poinsettia. However, it is hard to justify such a high cost of preventative releases unless the pest is actually present.

Overall we were very satisfied with the growing medium, which was more expensive than conventional media, probably because organic greenhouse production is still a small market. Challenges were that (a) the medium had been stored for nine months before we used the material, so we had to drench twice with yucca extract to improve wettability, and more importantly (b) the medium would have been improved with more perlite, because poinsettia is a long-term crop grown in dark months that is sensitive to overwatering. Because we had to drench with low-toxicity materials for pest management, repeated applications were necessary (where one application might have been adequate with conventional pesticides) and more rapid drying of the medium would therefore have been especially helpful for organic production. The yucca wetting agent was low cost and easy to apply along with the fertilizer and definitely improved wettability of the media.

Although the fertilizer was expensive, we did not fertilize as often as we normally would with a synthetic water-soluble fertilizer such as 20-10-20. Presumably this was because of a combination of reduced leaching of nutrients (with slow release of N) and slow release from the preplant charge in the medium. At $52.39 per gallon, the fertilizer was 23 times the cost per unit of nitrogen compared with 20-10-20. Shipping liquid fertilizer from the California supplier to New Hampshire does not make environmental common sense. Within New England, we found a liquid fish fertilizer but did not use that material because of the odor (in contrast, Omega 6-6-6 had an acceptable odor). There are other potential nutrient sources, such as surface applied plant or animal products, that may be lower in cost. The liquid fertilizer had the advantage of being easy to apply and could be applied incrementally without risk of high salts.

The increased losses from pythium indicate to me that lack of curative fungicide products may be a problem for organic growers. As noted above, we drenched with a beneficial fungus, but this is not intended as a curative material and had to compete with pythium on some of the cuttings, plus continued root damage from fungus gnats.

Total direct costs were $4.26 for the organically-grown crop, compared with $1.26 as typical costs for a conventionally-grown poinsettia. This means that using our growing method, an additional $3 sales price per plant would be needed to break even on poinsettia. Organic production is a niche market, whereas poinsettias are treated as a commodity product. Therefore, sales through health food stores and similar outlets might attract a premium. In addition, our managment approach for the poinsettia crop next season (2005) will emphasize ways to reduce production cost.

Table 2. Budget for organic poinsettia crop at UNH. Estimated commercial organic costs assume that we applied materials at commonly recommended levels for commercial crops. Conventional commercial figures are based in part on work by Dr. John Biernbaum from Michigan State University.

Organic Poinsettia Direct Costs
University of New Hampshire, 2004
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	Notes	Number	Frequency	Cost / unit	Unit size	Rate	Cost/240 pots actual UNH organic	Cost/240 pots estimated commercial organic	Cost/pot estimated commercial organic	Cost/pot estimated commercial conventional
Cutting		240		$0.70	1	240 pots, 1 cutting/pot	**$168.00**	**$168.00**	**$0.70**	**$0.70**
Pest and disease controls										
Eretmocerus eremicus	parasitic wasp, silverleaf and sweetpotato whitefly control	13	weekly	$52.49	3000	1 unit used at each release date. Normally 15 insects/sq.yd. (in UNH case 45/sq.yd.)	$682.37	$227.46	$0.95	Imidacloprid (1.3 g/pot), fungicide (3 drenches), 3 pesticide drenches for fungus gnats, chlormequat growth retardant (once at 1500 ppm), with 2% losses assumed below. Based on work by John Biernbaum, Michigan State University
Encarsia formosa	parasitic wasp, greenhouse whitefly control	6	biweekly	$11.37	1000	1 unit used at each release date, normally 10 insects/sq.yd. (in UNH case, 15/sq.yd.)	$68.22	$45.48	$0.19	
Hypoaspis miles	predatory mite, fungus gnat control	6	biweekly	$19.71	7500	1 unit used at each release date, normally 160 insects/sq.yd. (in UNH case 113/sq.yd.)	$118.26	$167.45	$0.70	
Steinernema feltiae	parasitic nematode, fungus gnat control	3	triweekly after September	$14.85	1 million	1 unit used at each release date, normally 1 mil/2000 sq.ft. (in UNH case, 1 million/600 sq.ft.)	$44.55	$13.37	$0.06	
Neem extract		6	7 days apart in groups of 3 drenches	$181.00	qt	30 ml (1 oz) used at each application	$33.94	$33.94	$0.14	
Trichoderma harzianum		3	monthly	$187.20	3 lb	Approx. 3 oz used at each application	$35.10	$35.10	$0.15	
Bacillus thuringiensis		1	at planting	$84.44	2.5 gal	0.18 gal/application	$6.08	$6.08	$0.03	
Total pest and disease control							**$988.52**	**$528.87**	**$2.20**	**$0.22**
Fertilizer, media, and pots										
Yucca Extract wetting agent		2	early and middle of crop	$36.46	qt	4 oz/100 gal (2 oz total used)	$2.28	$2.28	$0.01	
SunGro Organic Growing Mix		5		$11.20	2.8 cu.ft.		$56.00	$56.00	$0.23	$0.13
Omega 6-6-6 liquid fertilizer		8	1.75 gallons total	$52.39	gall		$91.68	$91.68	$0.38	$0.01
Containers				$42.81	250		$41.10	$41.10	$0.17	$0.17
Total fertilizer, media, pots							**$191.06**	**$191.06**	**$0.80**	**$0.31**
Subtotal direct costs							**$1,347.58**	**$887.93**	**$3.70**	**$1.23**
Losses	*Pythium* root rot	10%					**$134.76**	**$134.76**	**$0.56**	**$0.02**
Direct costs including losses							**$1,482.33**	**$1,022.68**	**$4.26**	**$1.26**

Notes

Fixed costs (heating, insurance, labor, etc.) typically add $0.20 to $0.30 per sq.ft. week, and a 6-inch poinsettia typically requires approx. 15 sq.ft. weeks. This would add $3.00 to $4.50 per pot cost to both organic or conventional crops compared with totals above.

An additional cost for packaging/shipping (sleeve, etc.) can easily add $0.35 or more to the cost per pot.

Appendix 1 Technical information on organically-acceptable soil amendments

From: Potting Mixes for Certified Organic Production (WWW.ATTRA.ORG)
Horticulture Technical Note By George Kuepper, NCAT Agriculture Specialist and Kevin Everett, Program Intern, September 2004, ATTRA Publication #IP112

Organic media components include: composted pine bark, peat, coir, newspaper, alfalfa, kenaf, sawdust, clay, perlite, vermiculite, and limestone (calcium carbonate or dolomite).

Table 1. A Selection of Organic Fertilizers for Use in Growing Media[a]

Fertilizer Material	**Estimated**			**Rate of Nutrient Release**	**Salt & pH Effects**
	N	**P**	**K**		
Alfalfa Meal	2.5	0.5	2.0	Slow	
Blood Meal	12.5	1.5	0.6	Medium-Fast	
Bone Meal	4.0	21.0	0.2	Slow	
Cottonseed Meal[b]	7.0	2.5	1.5	Slow-Medium	Tends to acidify
Crab Meal	10.0	0.3	0.1	Slow	
Feather Meal	15.0	0.0	0.0	Slow	
Fish Meal	10.0	5.0	0.0	Medium	
Granite Meal	0.0	0.0	4.5	Very Slow	
Greensand	0.0	1.5	5.0	Very Slow	
Bat Guano	5.5	8.6	1.5	Medium	
Seabird Guano	12.3	11.0	2.5	Medium	
Kelp Meal	1.0	0.5	8.0	Slow	Possibly high-salt
Dried Manure	Depends on Source			Medium	Possibly high-salt
Colloidal Phosphate	0.0	16.0	0.0	Slow-Medium[c]	
Rock Phosphate	0.0	18.0	0.0	Very Slow-Slow[c]	
Soybean Meal	6.5	1.5	2.4	Slow-Medium	
Wood Ash	0.0	1.5	5.0	Fast	Very alkaline, salts
Worm Castings	1.5	2.5	1.3	Medium	

(a) Information in the table has been adapted primarily from Penhallegon, Ross. 1992. Organic fertilizer NPK values compiled. In Good Tilth. January. p. 6.; and Rodale Staff. 1973. Organic Fertilizers: Which Ones and How To Use Them. Rodale Press, Emmaus, PA. p. 50.

(b) Cottonseed meal from many sources may be too contaminated by routine pesticide use to be permitted in certified production. Growers should consult their certifiers before using.

(c) The availability of phosphorus in different forms of rock phosphate depends on the pH of the mix, biological activity, fineness of grind, and the chemical composition of the source rock. Precise performance is not easy to predict.

Appendix 2. Selected sections of the National Organic Program Standards that apply to greenhouses

Here are some key selected sections from the National Organic Program Standards. Some sections are paraphrased. This information is included for education and not regulatory purposes:

205.100 What has to be certified.

[E]ach production or handling operation or specified portion of a production or handling operation that produces or handles crops, livestock, livestock products, or other agricultural products that are intended to be sold, labeled, or represented as "100 percent organic," "organic," or "made with organic (specified ingredients or food group(s))"..

205.101 Exemptions and exclusions from certification

A production or handling operation that sells agricultural products as "organic" but whose gross agricultural income from organic sales totals $5,000 or less annually is exempt from certification...

205.401 Application for Certification.

A person seeking certification of a production or handling operation under this subpart must submit an application for certification to a certifying agent. The application must include [an organic production or handling system plan, and there are annual onsite inspections. The certifying agents are approved by USDA and are mainly either state departments of agriculture or organic farming organizations]..

205.102 Use of the term, "organic."

Any agricultural product that is sold, labeled, or represented as "100 percent organic," "organic," or "made with organic (specified ingredients or food group(s))" must be [produced and handled in accordance with the requirements]

205.202 Land requirements.

Any field or farm parcel from which harvested crops are intended to be sold, labeled, or represented as "organic," must have had no prohibited substances, as listed in § 205.105, applied to it for a period of 3 years immediately preceding harvest of the crop; and

(c) Have distinct, defined boundaries and buffer zones such as runoff diversions to prevent the unintended application of a prohibited substance to the crop or contact with a prohibited substance applied to adjoining land that is not under organic management.

Excluded methods [genetic engineering]. A variety of methods used to genetically modify organisms or influence their growth and development by means that are not possible under natural conditions or processes and are not considered compatible with organic production. Such methods include cell fusion, microencapsulation and macroencapsulation, and recombinant DNA technology (including gene deletion, gene doubling, introducing a foreign gene, and changing the positions of genes when achieved by recombinant DNA technology). Such methods do not include the use of traditional breeding, conjugation, fermentation, hybridization, in vitro fertilization, or tissue culture.

205.203 Soil fertility and crop nutrient management practice standard.

(c) The producer must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances. Animal and plant materials include:

(1) Raw animal manure, which must be composted unless it is:

(i) Applied to land used for a crop not intended for human consumption;

(ii) Incorporated into the soil not less than 120 days prior to the harvest of a product whose edible portion has direct contact with the soil surface or soil particles; or

(iii) Incorporated into the soil not less than 90 days prior to the harvest of a product whose edible portion does not have direct contact with the soil surface or soil particles;

(2) Composted plant and animal materials produced though a process that

(i) established an initial C:N ratio of between 25:1 and 40:1; and

(ii) maintained a temperature of between 131 F and 170 F for 3 days using an in-vessel or static aerated pile system; or

(iii) maintained a temperature of between 131F and 170F for 15 days using a windrow composting system, during which period, the materials must be turned a minimum of five times.

(3) Uncomposted plant materials.

(d) A producer may manage crop nutrients and soil fertility to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances by applying:

(1) A crop nutrient or soil amendment included on the National List of synthetic substances allowed for use in organic crop production;

(2) A mined substance of low solubility;

(3) A mined substance of high solubility, Provided, That, the substance is used in compliance with the conditions established on the National List of nonsynthetic materials prohibited for crop production;

(4) Ash obtained from the burning of a plant or animal material, except as prohibited in paragraph (e) of this section: Provided, That, the material burned has not been treated or combined with a prohibited substance or the ash is not included on the National List of nonsynthetic substances prohibited for use in organic crop production; and

(5) A plant or animal material that has been chemically altered by a manufacturing process: Provided, That, the material is included on the National List of synthetic substances allowed for use in organic crop production established in § 205.601.

(e) The producer must not use:

(1) Any fertilizer or composted plant and animal material that contains a synthetic substance not included on the National List of synthetic substances allowed for use in organic crop production;

(2) Sewage sludge (biosolids) as defined in 40 CFR Part 503; and

(3) Burning as a means of disposal for crop residues produced on the operation: Except, That, burning may be used to suppress the spread of disease or to stimulate seed germination.

205.204 Seeds and planting stock practice standard.

(a) The producer must use organically grown seeds, annual seedlings, and planting stock: Except, That,

(1) Nonorganically produced, untreated seeds and planting stock may be used to produce an organic crop when an equivalent organically produced variety is not commercially available, Except, That, organically produced seed must be used for the production of edible sprouts;

(2) Nonorganically produced seeds and planting stock that have been treated with a substance included on the National List of synthetic substances allowed for use in organic crop production may be used to produce an organic crop when an equivalent organically produced or untreated variety is not commercially available;

(3) Nonorganically produced annual seedlings may be used to produce an organic crop when a temporary variance has been granted in accordance with § 205.290(a)(2);

(4) Nonorganically produced planting stock to be used to produce a perennial crop may be sold, labeled, or represented as organically produced only after the planting stock has been maintained under a system of organic management for a period of no less than 1 year; and

(5) Seeds, annual seedlings, and planting stock treated with prohibited substances may be used to produce an organic crop when the application of the materials is a requirement of Federal or State phytosanitary regulations.

205.206 Crop pest, weed, and disease management practice standard.

(a) The producer must use management practices to prevent crop pests, weeds, and diseases including but not limited to:

(1) Crop rotation and soil and crop nutrient management practices, as provided for in §§ 205.203 and 205.205;

(2) Sanitation measures to remove disease vectors, weed seeds, and habitat for pest organisms; and

(3) Cultural practices that enhance crop health, including selection of plant species and varieties with regard to suitability to site-specific conditions and resistance to prevalent pests, weeds, and diseases.

(b) Pest problems may be controlled through mechanical or physical methods including but not limited to:

(1) Augmentation or introduction of predators or parasites of the pest species;

(2) Development of habitat for natural enemies of pests;

(3) Nonsynthetic controls such as lures, traps, and repellents.

(d) Disease problems may be controlled through:

(1) Management practices which suppress the spread of disease organisms; or

(2) Application of nonsynthetic biological, botanical, or mineral inputs.

(f) The producer must not use lumber treated with arsenate or other prohibited materials for new installations or replacement purposes in contact with soil or livestock.

205.272 Commingling and contact with prohibited substance prevention practice standard.

(a) The handler of an organic handling operation must implement measures necessary to prevent the commingling of organic and nonorganic products and protect organic products from contact with prohibited substances.

205.601 Synthetic substances allowed for use in organic crop production.

In accordance with restrictions specified in this section, the following synthetic substances may be used in organic crop production: Provided, That, use of such substances do not contribute to contamination of crops, soil, or water. Substances allowed by this section, except disinfectants and sanitizers in paragraph (a) and those substances in paragraphs (c), (j), (k), and (l) of this section, may only be used when the provisions set forth in § 205.206 (a) through (d) prove insufficient to prevent or control the target pest. [The selected list includes:

As algicide, disinfectants, and sanitizer, including irrigation system cleaning systems: includes calcium hypochlorite, sodium hypochlorite, chlorine dioxide, hydrogen dioxide, ozone gas, peracetic acid, soap-based algicide

As herbicides: Soap-based herbicides on ornamental crops.

As insecticides (including acaricides or mite control): Elemental sulfur, horticultural oils, and insecticidal soaps

As plant disease control.

(1) Coppers, fixed - copper hydroxide, copper oxide, copper oxychloride, includes products exempted from EPA tolerance, Provided, That, copper-based materials must be used in a manner that minimizes accumulation in the soil and shall not be used as herbicides.

(2) Copper sulfate - Substance must be used in a manner that minimizes accumulation of copper in the soil.

(3) Hydrated lime.

(4) Hydrogen peroxide.

(5) Lime sulfur.

(6) Oils, horticultural, narrow range oils as dormant, suffocating, and summer oils.

(7) Peracetic acid - for use to control fire blight bacteria.

(8) Potassium bicarbonate.

(9) Elemental sulfur.

As plant or soil amendments.

(1) Aquatic plant extracts (other than hydrolyzed) - Extraction process is limited to the use of potassium hydroxide or sodium hydroxide; solvent amount used is limited to that amount necessary for extraction.

(2) Elemental sulfur.

(3) Humic acids - naturally occurring deposits, water and alkali extracts only.

(4) Lignin sulfonate - chelating agent, dust suppressant, floatation agent.

(5) Magnesium sulfate - allowed with a documented soil deficiency.

(6) Micronutrients - not to be used as a defoliant, herbicide, or desiccant. Those made from nitrates or chlorides are not allowed. Soil deficiency must be documented by testing.

(i) Soluble boron products.

(ii) Sulfates, carbonates, oxides, or silicates of zinc, copper, iron, manganese, molybdenum, selenium, and cobalt.

(7) Liquid fish products - can be pH adjusted with sulfuric, citric or phosphoric acid. The amount of acid used shall not exceed the minimum needed to lower the pH to 3.5.]