The New York Berry News

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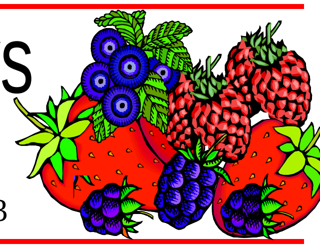

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What's Inside

Happy New Year! This is the first issue of the second volume of the NY Berry News. In this issue of the NYBN results of fungicide trials conducted at the NY State Agriculture are presented. The use of fungicides (or pesticides in general) in commercial agriculture tends to be a reality that many would prefer to see disappear. In fact, organic berry production is probably the fastest growing segments in small-farm or direct-marketing agriculture. In this issue Marvin Pritts puts organic strawberry production in perspective. In the search for non-pesticidal tactics for disease management (i.e, other than the use of resistant varieties, sanitation, and weed management!), we take a closer look at compost teas as a possible alternative.

Current News & Events:

January 22-25, 2003: *North American Strawberry Growers Association Annual Meeting*, Puerto Vallarta, Mexico. Contact Erin Griebe at 810-229-9407. Email: NASGAHQ@aol.com.

January 29, 2003: *New York State Berry Growers Association Annual Meeting* (in conjunction w/ *NY Farmers Direct Marketing Association*) will be held at Sheraton Inn Conference Center in Saratoga Springs, NY. For more information or for registration materials contact the NY Farmers Direct Marketing Association at 315-475-1101. Or send inquiries to 7350 Collamer Road, East Syracuse, NY 13057.

February 1, 2003: *New England Vegetable and Berry Growers*, Waltham Field Station, Waltham, MA. Commercial Members Day Trade Show. Contact: Dominic Marini 508-378-2546.

February 4-6, 2003: *The Mid-Atlantic Fruit &Vegetable Growers Conference* will be held at the Hershey Lodge and Convention Center in Hershey, Pa. For more information contact Maureen Irvin, 717-677-4184.

February. 7-8, 2003: *North American Bramble Growers' Association* will meet in Leesburg Virginia. The meeting will be held at the Holiday Inn at the Historic Carradoc Hall. Contact Jason Murray, Commercial Horticulture Agent, for further information, at jamurray@vt.edu or 703-737-8978. You can view the program at http://www.ento.vt.edu/Fruitfiles/NABGAProgram03.pdf

February 11, 2003: *Vermont Vegetable & Berry Growers Association Annual Meeting*, will be held at the Holiday Inn in Rutland Vermont. For more information contact: Vern Grubinger, (802) 257-7967 (ext. 13) or E-mail: vernon.grubinger@uvm.edu.

February 18-19, 2003: *The Niagara Peninsula Fruit & Vegetable Growers' Association* and the *Ontario Horticultural Crops Conference* have joined together to bring the Ontario Fruit & Vegetable Convention (OFVC). The meeting will be held at Brock University in St Catharines, Ontario. For more information contact Chairman: Tony Sgambelluri 905-945-1713; Vice Chair: Bob Cobbledick 905-945-9057.

March 27, 2003: A one-day workshop sponsored by the University of Guelph on *Growing Raspberries in Greenhouses* will be held in Simcoe, Ontario, Canada from 8:30 am - 4:30 pm. Speakers include: Adam Dale, Marvin Pritts, Doug Balsillie, Glenn Fox and Tom Wood. Doug Balsillie and Tom Wood are among the largest greenhouse raspberry growers in North America. From more information: Department of Plant Agriculture, 1283 Blueline Road. Phone: 519-426-7127 ext. 333 or email adale@ uoguelph.ca. Or you may contact Max Welcome (mw45) for a brochure.

Nation's 2002 Census of Agriculture Report Forms due February 3

Farmers and ranchers are reminded that the deadline for returning their 2002 Census of Agriculture report form is Feb. 3, 2003. A large number of report forms have been completed and returned, according to USDA's National Agricultural Statistics Service (NASS), the agency responsible for conducting and producing results from the census of agriculture. For those who have not completed their report form yet, estimates are acceptable if records are not available. Those not operating a farm or ranch who have received a census of agriculture form should return it so they will not be contacted again. Operators who have not returned their form should be aware that response to the census is required by law (Title 7, U.S. Code). Delays increase the cost of the census and cause further mail and personal follow-ups. Help completing the census report form is only a free phone call away at 1-888-4AG-STAT. Those with questions about completing the form, or who did not receive a form by February but believe they qualify as a farm or ranch, can call the toll-free number. All information collected in the census of agriculture is kept strictly confidential by law. This 26th census will provide a detailed picture of the current status of agriculture, across the Nation's 3,000 plus counties, and changes since the last census was taken five years ago. Results from previous censuses and hundreds of current agricultural statistics may be found at www.usda.gov/nass/. By responding to the census, America's farmers and ranchers make it known - agriculture counts!

2000 Direct Marketing Survey Highlights

The New York Agricultural Statistics Service has released the results of the 2000 Direct Marketing Survey. This was a state wide survey which provides detailed information on the nature, extent, and economic value of direct marketing in New York. Presented here are the highlights of the survey. The complete report can be accessed at www.nass.usda.gov/ny and clicking on the Special Survey link.

Report Highlights

- Results of the 2000 Direct Marketing Survey show there were 6,667 producers selling agricultural products directly to consumers, up from 6,125 in 1987. This was nearly 18 percent of all New York farms. Value of these sales was over $230 million, more than double the value in 1987.
- Average sales for farms selling products directly to consumers in 2000 was $34,530, almost double the 1987 average of $18,328.
- Nursery and greenhouse products had the highest value of direct sales, over $107 million compared with only $45.2 million in 1987.
- Vegetable direct sales totaled $36.7 million in 2000, up from $24.4 million in 1987.
- Fruit direct sales was third most important at $36.7 million, nearly triple the sales of $12.8 million in 1987.
- Meat, poultry and dairy direct sales in 2000 was $14.5 million, compared with $19.5 million in 1987.

Numerical Highlights

Number of Farms in New York	38,000
Number Direct Marketing to Consumers	6,667
Percent of Total	% 17.5
Total Direct Sales (000)	$ 230,213
Average Sales Per Farm Selling Direct	$ 34,530
All Farm Cash Receipts (000)	$ 3,125,415
Direct Sales Percent	% 7.4
Fruit Direct Sales (000)	$ 36,673
Number Selling Direct	1,644
Vegetable Direct Sales (000)	$ 36,681
Number Selling Direct	2,259
Nursery and Greenhouse Direct Sales (000)	$ 107,275
Number Selling Direct	2,641
Meat, Poultry and Dairy Direct Sales (000)	$ 14,465
Number Selling Direct	1,666
Other Ag Products Direct Sales (000)	$ 35,119
Number Selling Direct	2,701

Fungicide Trials: Results 2002

Bill Turechek, Dept. of Plant Pathology, Cornell University, Geneva, NY

Fungicides are almost always needed to manage disease in commercial strawberry production. Fortunately, there are a number of fungicides available. But which of these to choose and when to apply them is not always a simple question to answer. Growers typically rely on University Extension to evaluate the efficacy of currently labeled fungicides, those in which companies are seeking registration, and those which may show promise for that crop. Last year we conducted two fungicide trials. In the first trial, we evaluated the performance of a variety of registered fungicides and fungicides currently in the process of receiving federal and/or NY registration. In this trail 4 applications were applied during bloom. Although rarely needed under commercial conditions, 4 applications assure that complete coverage is achieved during bloom which is necessary to under experimental conditions to eliminate any confounding factors that may interfere with the performance of the fungicide. A second trial was run to evaluate the performance of mainly currently registered fungicides under a 2-spray program: 1 application at 10% bloom and another 10 days later.

Methods: The trials were performed in a 2-year-old planting on one of the NY Agricultural Experiment Stations research farms. Plants were grown in a matted-row system, with fruiting rows approximately 1.5 ft wide on 4 ft centers. Individual plots consisted of 12 ft sections of planting row with 3 ft buffer zones on either end of the row and between each treatment within the row. Treatments were replicated 4 times in a randomized complete blocks design. To ensure uniform disease pressure, berry halves inoculated with 3 different strains of the gray mold pathogen *Botrytis cinerea* were placed evenly throughout each plot, approximately 3 berry halves per plot, after treatments were dry on each day applications were made.

All fungicide treatments were applied with a 2 gallon hand sprayer during bloom. In trial #1 applications were made on 16, 23, 29 May, and 3 June 2002, corresponding to applications 1, 2, 3, and 4, respectively, in table 1 below. Fruit were harvested on 19, 24, and 27 Jun. In trial #2 applications were made on 23 May and 7 days later on 30 May 2002. Fruit were harvested on 18, 21, and 26 Jun. The number and weight of berries with and without symptoms were recorded the same day they were harvested. Subsamples of unblemished, symptomless berries from each plot picked were placed on individual mesh screens in wooden flats, by inserting the stem end through the mesh. The number of fruit per sample was variable, being determined by the number of unblemished berries available for screening and the amount of berries that could fit on each screen without berry-to-berry contact. The berries were incubated 4 days at 68^{o}F and 95-97% relative humidity. After incubation the number of healthy and diseased fruit were recorded to determine post harvest disease incidence. Data were analyzed with analysis of variance and treatment means were separated using Tukey's Studentized Range Test ($P<0.05$). Treatments followed by the same letter are not statistically different from each other.

Results trial #1: Four infection events occurred during bloom. The amount of precipitation and the average temperature for each infection period were: (1) 16-18 May, 0.68 in, 47 F; (2) 25 May, 0.26 in, 54 F; (3) 29-31 May, 1.46 in, 70 F; and (4) 4-5 Jun, 0.75 in, 63 F. Treatments rated at harvest could be placed into one of three groupings (Table 1): those which provided control statistically equivalent to the best treatment (i.e., CGA173506 (a formulation of the fungicide Scholar (fludioxonil)) used in alternation with Captan); those which did not perform better than the untreated check; and those which could be classified in to both categories. Treatments in the first grouping had less than 5% disease, treatments in the second grouping had greater than 6% disease, and treatments in the last grouping had disease between 5 and 6%. Greater separation among treatments was evident after postharvest treatment. BAS 516 (a premix of BAS 510 and BAS 500 (BAS500 was recently labeled as Cabrio EG)) and BAS 510 provided the best level of control along with Elevate 50WG, the high rate of TM45002 (and experimental premix formulation of Elevate and Captan), and Switch 62.5WG used in stand-alone schedules. As anticipated, the strobilurin BAS 500 did not provide any appreciable level of control of gray mold. Captan 50WP or 80WP when used alone, in mixture, or in alternation provided marginal control, but significantly better control than the untreated check.

Results trial #2: Three infection events were recorded during bloom corresponding to the last three infection events above. All 2-spray programs provided significantly better control than the untreated check when berries were rated at harvest. Switch 62.5WG and Elevate 50WG provided significantly better control of gray mold than the untreated check when rated post harvest. Interestingly, the untreated check had significantly less gray mold than the Captan 50WP treatment at post harvest evaluation.

A note about the fungicides in trial. Switch 62.5WG has recently received a federal label for use against grey mold on strawberry; it has NOT received a NY label. We anticipate a NY label in 2004. Cabrio EG (aka BAS500) has also received a federal label but NOT a NY label. Cabrio EG is registered for use on strawberry, blueberry, raspberry, and other caneberries and is labeled for use against anthracnose, many of the cane diseases, as well as several foliar diseases; it is not labeled, nor is it particularly active, against gray mold. TM45002 is a premix of Elevate 50WG and Captan produced by Arvesta. The product is in the developmental stage but we anticipate a NY registration in the next few years.

Table 1. Percentage of diseased fruit at harvest and post harvest for trial #1.

Treatment (Rate/A)	Timing	% Infection (postharvest)	% Infection (harvest)
BAS 516 (1.45 lb)	1-4	4.0 a	4.3 ab
BAS 510 (0.529 lb)	1-4	5.1 a	6.2 ab
CGA173506 (0.437 lb) then Elevate 50 WG (1.5 lb)	1,2 3,4	6.1 a	4.3 ab
Elevate 50 WG (1.5 lb)	1-4	6.2 a	5.6 ab
TM45002 (5.25 lb)	1-4	7.1 ab	6.5 ab
Switch 62.5 WG (0.875 lb) alt. w/ Quadris 2.08 SC (0.9 Lpr/HA)	1,3 2,4	9.4 ab	3.6 ab
Switch 62.5 WG (0.875 lb)	1-4	9.7 ab	5.0 ab
TM45002 (3.5 lb)	1-4	11.1 ab	2.9 ab
Captan 80 W (3.75 lb)	1-4	11.6 ab	4.4 ab
Elevate 50 WG (1 lb) + Captan 50 W (3.75 lb)	1-4	11.7 ab	5.9 ab
CGA173506 (0.437 lb) alt. w/ Captan 50 W (4 lb)	1,3 2,4	12.3 ab	5.5 ab
Elevate 50 WG (1.5 lb) + Captan 50 W (5.63 lb)	1-4	13.0 ab	4.3 ab
Switch 62.5 WG (0.875 lb) then Elevate 50 WG (1.5 lb)	1,2 3,4	13.1 ab	5.0 ab
CGA173506 (0.437 lb) then Captan 50 W (4 lb)	1,2 3,4	13.2 ab	2.2 a
Switch 62.5 WG (0.875 lb) then Captan 50 W (4 lb)	1,2 3,4	15.3 abc	4.7 ab
Captan 50 W (4 lb) then CGA173506 (0.437 lb)	1,2 3,4	16.8 abc	6.8 ab
Switch 62.5 WG (0.875 lb) alt. w/ Captan 50 W (4 lb)	1,3 2,4	17.1 abc	7.2 ab
Captan 50 W (6 lb)	1-4	19.0 abc	6.3 ab
BAS 500 (Cabrio EG (0.9 lb))	1-4	21.4 bc	9.0 b
UTC		29.3 c	9.3 b

Table 2. Percentage of diseased fruit at harvest and post harvest for trial #2.

Treatment (Rate/A)	% Infection (harvest)	% Infection (postharvest)
Switch 62.5 WG (0.875 lb/A)	4.1 a	9.3 a
Rovral (2 lb/A)	8.0 ab	14.3 abc
Topsin-M WSB (1 lb/A)	10.1 ab	18.0 bc
Elevate 50 WG (1.5 lb)	10.2 ab	13.0 ab
Captan 50W (6 lb/A)	11.7 b	28.1 d
Thiram 65WSB (2.5 lb/A)	12.1 b	19.9 bc
Control	20.9 c	20.3 c

Organic Strawberry Production Systems

Marvin Pritts[1] and Joe Kovach[2]
[1]Dept. of Horticulture, Cornell University, Ithaca, NY; [2]IPM Program, OARDC, Ohio State University, Wooster, OH

Demand for organically grown produce has been increasing significantly over the past decade as the public often perceives organic produce to be healthier than conventional fruits and vegetables. Although no data exist to support this belief, a portion of consumers is willing to pay extra for organics. Tomatoes, sweet corn, lettuce, onions, carrots, melons and strawberries already are produced by organic growers in significant quantities.

Can strawberries be grown organically for a profit? Organic strawberry systems have 5 characteristics in common, regardless of the location in which they are grown: 1) Several years between successive crops; 2) Short production cycle (1-2 fruiting years); 3) High labor requirements; 4) Lower yields; and 5) Greater variability in yields. All of these characteristics result in a greater expense for the organic grower than the conventional grower, but if the price of berries is higher, then production can be profitable.

For example, organic and conventional annual strawberry production systems were examined in California over a three year period (Table 1). Both systems cost a similar amount to establish ($22,000/acre-year), and the organic system yielded less (27,100 vs. 40,200 lb/A), but the organic system averaged a higher return because the price received for fruit was 50% higher (Calif. Ag. 50:24-31).

Table 1. Characteristics of two production systems in California after three years.

Organic	Conventional
More insect pests	Fewer insect pests
More insect predators	Fewer insect predators
More harmless nematodes	Fewer harmless nematodes
Decreasing soil organic matter	Decreasing soil organic matter
Smaller plants	Larger plants
Lower yields	Higher yields

In an attempt to determine the costs of production and breakeven price for organic matted row strawberries, a comprehensive spreadsheet developed by Alison DeMarree (Cornell Cooperative Extension) and Regina Rieckenberg (Valent USA) was used to calculate production costs and profit for matted row strawberries, and the assumptions were changed to conform to organic production. For example, any costs for synthetic inputs such as fertilizers and pesticides were eliminated, but yields were reduced by 30 - 70% as well - with the greatest decrease in later years. For example, in fruiting years 1 - 4, conventional yields were set at 7,000, 7,000, 4,000 and 3,000 qts/A, whereas organic yields were set at 5,000, 4,000, 2,000 and 1,000 qts/A. 104 hours of labor we assigned to weed the organic fields, but only 52 hours per year to weed the conventional fields. All fruit was hand harvested for sale. Conventional prices were set at $1.75/qt. Organic prices were set at $2.00, although significantly higher prices can be obtained at urban markets (up to $3.50/qt.).

The breakeven price for the conventional system was $1.10/qt., whereas the breakeven price for the organic strawberries was 34% higher at $1.47/qt. By the 4th bearing year, however, organic strawberries were losing money. This supports the practice of many organic growers of fruiting their fields for only 2 years. If fields are rotated out of strawberries after 2 fruiting years, then a positive cash balance is obtained.

The enterprise budget for organic strawberries does not include the costs of a fallow period between cropping cycles, which is a real expense for organic growers. On the other hand, the fixed costs of both systems were set at equivalent values, even though an organic grower is likely to have less equipment (e.g. herbicide sprayer). Regardless of the details of the budget, one can conclude generally that organic strawberry production can be as profitable as conventional production if the price differential for fruit approaches 35 - 40%. This is consistent with the price differential required in the annual production system as well. The size of the market for $2.40/qt. berries is limited in many regions of North America, but not all. Therefore, a profit opportunity does exist for organic strawberries in certain marketing niches.

Organic production systems of the future - New techniques of nutrient and pest management are under development that could be used by organic strawberry growers to enhance their production and improve soil quality.

Use of specialized rotational cover crops - Planting berries through strips in a rye residue can enhance weed control in lighter soils. Recent work with marigolds, sudangrass, brassicas, and certain native prairie species (e.g. *Rudbeckia*) have found them to be suppressive to nematodes, pathogens and weeds. Certain of these may be particularly suited for rotations with strawberries, but might be too expensive for lower-value crops.

Use of interplanted cover crops - Interseeding oats and sudangrass between rows after harvest can supplement weed control, help improve soil structure, and improve winter mulching practices.

Use of entomopathogenic nematodes and fungi to manage insect pests - Special strains of nematodes are being developed that will attack grubs and weevil larvae in strawberry fields. Similarly, pathogens of insect pests are being developed and tested in strawberry fields. Once robust delivery methods are identified, then the use of these organisms will become routine.

Use of parasites/parasites to manage insect pests - Parasites of tarnished plant bug and sap beetle have already been tested in strawberry fields. The use of predatory mites is routine in some areas of Florida and California where the climate is mild. Development of hardy, adapted predators is a next step in achieving acceptable control. The techniques of molecular biology are being used to improve the adaptation of predatory mites in Florida.

A better understanding of thresholds - Strawberries appear to be able to tolerate more weed pressure in late August and September than earlier in the season. Also, recent work has suggested that strawberry plants can compensate for clipper injury by increasing the size of remaining fruit, indicating that for most growers in most years, strawberry clippers are not economically important pests. Improved scouting techniques, such as the use of white pan samples rather than sticky cards, have enabled growers to identify more precisely when tarnished plant bug damage actually occurs. This knowledge allows organic growers to make better management decisions.

Improvements in varieties - Many of the new strawberry varieties are resistant to several races of red stele and verticillium wilt, show tolerance to nematode feeding, and resist gray mold infection. Some show tolerance to feeding by tarnished plant bugs, and certain selections appear to be tolerant to black root rot. Most of these newer varieties have improved postharvest qualities, yet have maintained a high degree of flavor.

Use of analytical techniques to monitor nutrition - Soil and leaf testing services are available and being refined to enable organic growers to determine if nutrient levels are adequate, and to monitor long-term trends in soil fertility.

Key Features of Organic Berry Crop Production

Marvin Pritts, Professor and Chairman, Dept. of Horticulture, Cornell University, Ithaca, NY

Several years ago I was working with a strawberry grower who was having considerable problems with a syndrome called "black root rot." Scientists have not been able to identify a single cause for the occurrence of black lesions on roots that can lead to decline and death, although several organisms are often associated with the syndrome. The fungi *Phythium*, *Rhizoctonia* and the root lesion nematode *Pratylenchus* are most commonly associated with the decline, although other fungal species are frequently found in association, such as *Cylindrocarpon* and *Fusarium*. The risk of black root rot, also known as "replant disease," increases with the number of years that a particular site has been planted to strawberries. The North American Strawberry Growers Association has ranked it among the most serious concerns for growers nationwide.

Biological soil management

In the major strawberry-producing states of California and Florida, annual methyl bromide fumigation is practiced in order to grow strawberries continuously on the same site. In the north, annual production is not commonly practiced, so annual fumigation is not an option and northern growers do not fumigate routinely.

The grower was becoming frustrated with his farm operation and the increasing difficulty in growing his most profitable crop, despite a strong market. He found a job in another state and proceeded to sell the farm. A prospective buyer, an organic farmer, approached me about the potential for continuing to grow strawberries there. Admittedly, I was pessimistic because I knew that the organisms contributing to black root rot were present in the soil. However, the grower planted strawberries anyway.

About that time, my graduate student began surveying strawberry farms around New York State to see if she could identify factors that were associated with strawberry root health. After examining 104 variables on 54 sites, she found several factors that were associated with blackened roots: number of years in strawberry production, soil compaction, frequency of fumigation, and the use of the herbicide Sinbar.

I went back to visit the organic strawberry farmer after a couple of years, and was surprised by how healthy the plants appeared. Where were the blackened roots that had so predominated earlier plantings? What did the grower do in just a few years to eliminate this chronic problem? The grower explained to me that, in the course of his normal practices, he avoided all of the causes of the black roots that we found in our survey. He had an intensive plan for rotation that included cover crops, he used horses for cultivation to minimize soil compaction, he did not use herbicides that might stress the root system, and he did not fumigate so beneficial microorganisms were conserved.

Over the past several years we have been examining the influence of cover crops, composts, soil physical properties, and nutrient amendments on root health in raspberries and strawberries. Each of these has improved root health under controlled field conditions. For example, a rotation of hairy vetch-marigold-rye or hairy vetch-sudangrass-rye between perennial strawberry plantings has significantly improved growth and yield compared to no rotation or Vapam fumigation. This same rotation has given equivalent yields in old strawberry fields to plots fumigated with methyl bromide. We are currently examining a large number of cover crops and rotations to measure their effect on root health in a subsequent planting of strawberries. Several of these cover crops are prairie species known to suppress nematodes.

We have also documented benefits of using composts in strawberry plantings, and have found that compost can work significantly better than methyl bromide fumigation in at least some situations. This past summer we found that a compost amendment more than doubled yields in a site where strawberries were previously grown for several years. A cover crop of sudangrass prior to planting nearly doubled yields in the same field. We are currently examining the microorganisms in these sites to help determine the mechanism for the improved performance.

Raspberry roots also are susceptible to infection from *Phytophthora* species. We have shown that planting raspberries on raised beds can reduce the incidence of Phytophthora root rot to very low levels in susceptible varieties. We also discovered, rather serendipitously, that a gypsum (calcium sulfate) amendment suppressed this root rotting organism in replant sites. We were examining the effect of pH on root rot, modifying it with lime. We added a control treatment consisting of gypsum so that the equivalent amount of calcium was added without changing pH. To our surprise, the gypsum amended plots exhibited few Phytophthora symptoms. This effect was re-created under controlled greenhouse conditions. In the lab, free calcium ions were found to prevent completion of the life cycle of certain *Phytophthora* species.

The conclusions that we have made from this work are that good soil management through the use of raised beds, crop rotations, soil amendments, and compost use can enhance the long-term productivity of a berry planting, and can provide better management of root diseases than an approach that relies exclusively on pesticides and fumigants. Our work confirms that many of the practices utilized by organic growers enhance the ability of growers to produce strawberries consistently over many years.

Weed management

A second challenge of berry growers is weed control, particularly in the planting year. In surveys, berry growers indicate that weed control is their greatest expense and the cause of many problems. Few herbicides are labeled for use in strawberries, which has driven many conventional growers to consider annual planting systems that utilize black plastic mulch. This is true even in northern areas where annual production involves greater risk and expense. The trend towards plastic use greatly increases the environmental impact of strawberry production. In fact, strawberries growers already use enough black plastic mulch each year to circle the globe 13 times with a 1 meter wide sheet - and this does not include the plastic used for tarping fumigants.

Our approach has been to reconsider planting systems, and perhaps develop a new system that incorporates the advantages of annual plasticluture without the environmental disadvantages. Our first step was to identify the time period when weeds had the greatest impact on strawberry growth and productivity. Is the only good weed a dead weed? Are there times when weeds can be tolerated? How many weeds does it take to negatively influence production? We found that weed competition in June and July can seriously compromise the future yielding ability of a new planting of strawberries. In contrast, weed competition later in the season has little effect on yielding ability in the following year. If a field remains free of weeds during the establishment year, we found that it can take as much as three years before uncontrolled weed growth has an impact on productivity.

We examined procedures for managing weeds early in the planting year that did not involve hand-weeding, hoeing or herbicides. In one experiment, we tested 4 different cultivation implements in newly-planted strawberries: a standard multivator (rototiller), a flex-tine harrow, a finger weeder, and a brush hoe. The latter three implements were selected because they disturb on the top few inches of soil, compared to a rototiller that brings to the surface new weed seeds as it incorporates established weeds.

Our results were quite exciting. The brush hoe, in particular, showed promise for use in matted row strawberry production. Just two well-timed passes provided excellent seasonal weed control. The brushes moved runners back into the row, allowing cultivation to occur later in the season compared with other implements. The resulting layer of dust created by the implement "mulched" the field and suppressed weed seed germination. Yields were higher and costs lower (except for the implement itself) with the brush hoe compared to other implements or a more conventional approach to weed management.

We also adopted the concepts of "no till" and plasticulture into an alternative planting system for strawberries. The standard practice is to plant dormant crowns in a well-prepared seed bed in April about 18 inches apart and to allow runners to fill in the space between plants over the summer. The disadvantage is that weeds grow between the planted crowns until the runners become well-established. We compared the standard system to one in which dormant crowns were planted at a high density into a mowed cover crop of rye in early June. After planting, additional rye straw was applied between rows. Although runners could not establish within the row, this was not of concern because of the already high plant density. The rye cover and straw mulch provided a weed barrier, and since the soil was not cultivated prior to planting, weed seeds were not germinating at the soil surface. In addition, planting later in the season reduces runnering. We believe that this system provides much promise for reducing the effects of weeds in the planting year. However, currently available strawberry varieties were selected under matted row conditions - not under conditions where a strong root system is desirable for establishment in a rye sod.

We attempted to develop a rapid screening system to identify rapid and deep-rooting strawberry genotypes, without excavation, assuming that genotypes with stronger root systems would perform better in a "no till" planting system. The technique involves the removal of soil from a sloping field, leveling the site, applying norflurazon herbicide to the level ground, then replacing the soil over top of the herbicide to conform to the original slope. Individual genotypes are planted up the slope. As roots contact the herbicide, the chemical is translocated to the leaves where it inhibits pigment formation, causing the foliage to turn white. Those exhibiting the most rapid rooting exhibit discoloration up the slope first. A wide range of rooting ability was identified with this technique. For example, 'Honeoye' is considered to be susceptible to all types of root problems, and we found it to be a poorly rooting genotype. 'Jewel' is much more tolerant of root problems, and we found it to be the strongest root producer.

We planted raspberries through a rye residue as well, and compared their growth over the next several years with those of raspberries treated with standard practices. The rye residue greatly suppressed weed growth, and differences could be observed visually into the third growing season. However, raspberry growth also was slightly suppressed with the rye residue - regardless of plant type (dormant cane or tissue-cultured plug). We also inoculated rye with the beneficial fungus *Trichoderma* in an attempt to establish susceptible raspberries in a *Phytophthora*-infested site. However, the competition from the rye was greater than the beneficial effect of *Trichoderma*. Mulching with rye straw after planting greatly increased plant growth and suppressed weeds better than planting into a rye residue, cultivating, or using herbicides for weed suppression. We found, however, that mulching raspberries beyond the planting year was detrimental to cane growth, and provided a favorable environment for *Phytophthora*. Our current planting recommendations for raspberries are: 1) incorporate calcium sulfate (gypsum) at 6 tons/acre if the site has a history of *Phytophthora,* 2) plant on a raised bed, 3) use drip irrigation, 4) use straw mulch over top of the bed for weed suppression, and 5) do not replace the straw mulch.

A word about blueberries

Blueberries are among the easiest crops to grow organically. They have few pests that consistently bother them (except birds), and they thrive in acidic soils containing lots of organic matter. In fact, conventional nitrate-based fertilizers are toxic to blueberries. For these reasons, we have focused our research mostly on bird management, testing all sorts of devices and approaches to repellency. Among the many that we studied, the most effective is a species-specific bird distress call supplemented with a hawk silhouette and a sugar-syrup sprayed on the berry bushes just as the fruit is turning blue.

Summary

None of our results should be particularly surprising to organic growers. However, most growers, just like the rest of society, tend to choose the "quick fix" for problems, rather than implement long term procedures that prevent problems. It is the "quick fix" that is most amenable to packaging and advertising. Researchers and granting agencies also are under pressure to publish and show impact, thus avoiding long-term research. I believe that the contribution we are making is to take on the long term research projects, apply scientific rigor to these approaches, and help to incorporate them into both "organic" and "mainstream" agriculture.

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Compost Teas for Plant Disease Control

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In addition to well-known disease management methods — such as crop rotation, resistant cultivars, ensuring good aeration, planting clean seed, steam pasteurization, soil solarization — new and interesting approaches are being explored to suppress diseases through natural means and to reduce the use of synthetic fungicides. Compost teas, also known as compost watery extracts or simply compost extracts, are gaining increased attention as a crop protection tool for the control of foliar diseases, and as an inoculant to restore or enhance soil microflora. A selection of research from Germany, Japan, Israel, and the United States has shown compost extracts to be effective in the control of the following diseases (1):

Disease & Pathogen	Compost Tea (Reference)
Late blight of potato, tomato *Phytopthora infestans*	Horse compost extract (Weltzein 1990)
Gray mold on beans, strawberries *Botrytis cinerea*	Cattle compost extract (Weltzein 1990)
Fusarium wilt *Fusarium oxysporum*	Bark-compost extract (Kai et al 1990)
Downy & Powdery mildew on grapes *Plasmopara viticola* *Uncinula necator*	Animal manure-straw compost extract (Weltzein 1989)
Powdery mildew on cucumbers *Sphaerotheca fuliginea*	Animal manure-straw compost extract (Weltzein 1989)
Gray mould on tomato, pepper	Cattle & chicken manure compost extract Grape marc compost extract (Elad & Shtienberg 1994)
Apple scab *Venturia inaequalis*	Spent mushroom compost extract (Cronin et al. 1996)

Compost extracts enable biocontrol of plant pathogens through their action on the phyllosphere (i.e., leaf surface and associated microbes). A wide range of mechanisms—such as induced resistance, inhibition of spore germination, antagonism, and competition with pathogens—seem to contribute to the suppressive effect (2-3). The active components identified thus far in compost extracts include bacteria (*Bacillus*), yeasts (*Sporobolomyces* and *Cryptococcus*), and fungi, as well as chemical antagonists such as phenols and amino acids (2). Heat sterilization and/or filtration inactivated, or partially inactivated, efficacy of compost extracts thus indicating biological components play a significant role (2-3).

Factors influencing the efficacy of compost extracts include: age of compost; source of compost (animal manure based composts retain activity longer than composts solely of plant origin); type of target pathogen; method of preparation; mode, timing and frequency of application; and meteorological conditions (3). The efficacy of compost extracts can be enhanced by inoculation with beneficial microbes.

The methods by which compost watery extracts are prepared are changing as growers and researchers try new methods. However, there seems to be two somewhat divergent preparation methods: fermented versus aerated. The original extraction method, developed by the German researcher Heinrich Weltzein—a fermentation method—is promoted by Will Brinton (Woods End Agricultural Institute) on the East Coast of the United States. It can be summarized as follows:

> Compost teas were obtained by covering compost with tap water at a ratio between 1:5 to 1:8 (volume/volume). They were stirred once and allowed to ferment outdoors between 15° and 20° C (59-68° F). After a soaking period referred to as "extraction time" the solution was strained through cheesecloth and then applied with ordinary sprayers. Extraction periods ranged from 2 to 21 days, although most were between 3 to 7 days (4).

A modified method, gaining favor by a number of farmers on the West Coast, is promoted by Amigo Bob Cantisano (Organic Agriculture Advisors) and the Luebke family of Austria (founders of the Controlled Microbial Compost method). The "aerobic method" can be accomplished in several ways. A method described by Cantisano at the November 1995 Acres, U.S.A. Conference in St. Louis, MO, can be summarized as follows:

> Compost teas are prepared with a heavy emphasis on aeration. A 12- inch wide PVC pipe is cut in half lengthwise, laid on its side, and mounted several (at least 4 feet) above a tank that will hold the compost tea leachate. Next, numerous holes are drilled into the bottom of the PVC pipe to allow for drainage. Burlap bags containing compost are placed inside the trough created by the PVC pipe. A water line is run horizontally along the top of the trough. As the water collects and then runs through the burlap bags containing the compost, a leachate is created which then drops 4 feet through the air into the tank below. A sump pump in the bottom of the tank collects the leachate and distributes it back through the water line at the top of the trough, and so on. Through this process, which lasts about 7 days, the compost tea is recirculated, bubbled, and aerated.

Some variations that I am aware of include extraction periods of 2 to 8 hours instead of days, and burlap sacks full of compost held under running water as the spray rig is being filled.

Farmers in California seem to be the leaders in the adoption of this technology in the U.S., though there also appears to be usage among innovative farmers in the Pacific Northwest and East Coast regions. As one example, at the Tanimura & Antle vegetable farm in Salinas, California, compost extract is prepared in 4,000 gallon vats at a rate of 500 pounds compost per 500 gallons of water. Molasses, seaweed extract, algae, and yeast are added to the vats, which are aerated and allowed to brew for seven days. The compost tea, sold to growers for $0.10/gallon, is applied as a foliar drench at a rate of 100 gal/acre to young transplants or seedlings. The drench runs down the stem and wets the soil, thus inoculating both the foliage and soil in one application.

Compost tea preparation at Tanimura & Antle is one part of a soil renewal program that includes land-applied compost at 5 tons/acre. Tanimura & Antle happens to use the Luebke composting method, also known as Controlled Microbial Composting (CMC), but there are several composting procedures which can be employed in on-farm composting. The CMC method emphasizes a high quality, humified compost enriched with beneficial microorganisms. Information on this method can be found in a companion resource packet from ATTRA titled Controlled Microbial Composting & Humus Management, available on request. For a general overview and listing of resources on composting, see ATTRA's Farm-Scale Composting publication.

It is important to recognize that there is a clear distinction between finished compost and raw manure. While manures are used in forming windrows, the compost itself (having undergone physical, biological, and chemical transformations) is quite different from the parent material. Analytical compost quality criteria (e.g. chromatogram, phenolic profile, redox potential) and microbial analysis are clearly different from that of raw manure. Thus, pathogens associated with raw manures (e.g., human pathogens such as Listeria) can be avoided by using finished compost extracts. Growers who are new to composting and usage of compost extracts may want to enlist the services of an analytical lab for insight into compost quality and microbial diversity. Several labs that specialize in compost and microbial analysis are listed in the

ATTRA publication Alternative Soil Testing Laboratories (http://attra.ncat.org/attra-pub/soil-lab.html).

In addition to producing compost teas on-farm, there are several commercial suppliers of compost teas and enzyme-activated liquid manures in the U.S. (5–9). While enzyme-activated liquid manures are different from compost teas, they are often categorized as a product group in the organic fertilizer industry. How these two different products are used (soil or foliar applied) and how they function (soil inoculation and disease control versus liquid nutrients) are beyond the scope of this publication. For further information, contact the suppliers for technical assistance in how to use these commercial products and what results can be expected.

In summary, compost teas look rather promising as preventative sprays to suppress certain foliar diseases, as well as a means of replenishing (or enhancing) soil microflora. Farmers can use farm-produced composts to extract teas, or experiment with commercial compost tea products. Other natural disease control options that may be complementary to compost teas include whole-farm design (crop rotation schemes), naturally suppressive soils, disease-suppressive composts, microbial antagonists, and immune-building plant extracts (equisetum, valerian, stinging nettle).

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12. New Era Compost Services 23004 Road 140Tulare, CA 93274209-686-3833Contact: Ralph Jurgens
13. Agri-Energy Resources RR 2, Box 113 Princeton, IL 61356 815-872-1190 815-872-1928 Fax Supplier of AGREN® Compost Tea
14. Natural Resources Group 34284 Road 196, Building B Woodlake, CA 93286 209-564- 236 209-564-1238 Fax Email: thrncirik@aol.com Supplier of Nature's Solution® liquid chicken manure.

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