

Key Features of Organic Berry Crop Production

Marvin Pritts, Professor and Chairman, Dept. of Horticulture, Cornell University, Ithaca, NY, 14853



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, strawberry 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 plasticulture 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.

Selected references:

1. Pritts, M.P. and M.J. Kelly. 2001. Early season weed competition reduces yield of newly planted matted row strawberries. *HortScience* 36:729-731.
2. Wilcox, W.F., M.P. Pritts and M.J. Kelly. 1999. Integrated control of Phytophthora root rot of red raspberry. *Plant Disease* 83:1149-1154.
3. Pritts, M.P., M.J. Kelly and G. English-Loeb. 1999. Strawberry cultivars compensate for simulated bud weevil (*Anthonomus signatus* Say) damage in matted row plantings. *HortScience* 34:109-111.
4. Hancock, J.F., B.L. Goulart, J.J. Luby and M.P. Pritts. 1997. The strawberry matted row: practical cropping system of dated anachronism? *Adv. Strawberry Research* 16:1-4.
5. Soggi, A.M., M.P. Pritts and M.J. Kelly. 1997. Potential use of sucrose as a feeding deterrent for frugivorous birds. *HortTechnology* 7:250-252.
6. Wing, K. B., M.P. Pritts and W.F. Wilcox. 1995. Biotic, edaphic and cultural factors associated with strawberry black root rot in New York. *HortScience* 30:86-90.
Wing, K. B., M.P. Pritts and W.F. Wilcox. 1994. Strawberry black root rot: a review. *Advances in Strawberry Research* 13:13-

(Reprinted from: New York Berry News, [Vol. 2 No. 1, January 22, 2003.](#))