Buffer Zone Regulations and Alternatives to Pre-plant Soil Fumigation: Using Steam in California Strawberry Production

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The number of regulations regarding pre-plant soil fumigation is increasing. Buffer zones are required for methyl bromide and chloropicrin applications. Choosing application blocks, methods, and rates to maximize profits is becoming a difficult challenge for growers. One consideration is the management of the buffer zone. We consider the costs and returns of using steam for pre-plant soil disinfestation in a non-fumigated buffer zone.

California strawberry growers face an increasing number of regulations regarding preplant soil fumigation. Buffer zones are required for methyl bromide applications under state and federal rules, and for chloropicrin applications under the EPA's Phase II regulations (implemented December 2012). Additional state regulations regarding chloropicrin are currently under consideration by the California Department of Pesticide Regulation (CDPR).

Broadly speaking, growers may take one of four approaches to buffer zone management. First, the buffer zone may be left fallow but it will not produce any revenue and may incur costs, such as weed management costs. Second, an alternative crop that does not require pre-plant soil fumigation could be planted, which makes the logistics of farming the site more complex and less efficient. Third, the buffer zone could be planted in strawberries even though it is not fumigated. This could create a pathogen and pest reservoir that would affect production in the interior of the field. Finally, the buffer zone could be treated with a non-chemical alternative that is not subject to buffer zone requirements. We consider the costs and benefits of treating a buffer zone with pre-plant soil disinfestation using steam.

Current Fumigants and Regulations

In 2011 chloropicrin (CP) was used on 94% of all pre-plant soil fumigation of strawberry acreage. Of the total acres treated, 51% was treated with 1,3-dichloropropene (1,3-D) + CP, 33% with methyl bromide (MBr) + CP, 10% with CP alone, 4% with metam sodium, and 2% with metam potassium, according to CDPR's Pesticide Use Reporting database.

The December 2012 U.S. Environmental Protection Agency (EPA) Phase II regulations for CP include two sets of buffer zone requirements which are on all product labels: buffer zones surrounding difficult-to-evacuate sites (DES) and general buffer zones intended to limit exposure in order to protect human health. The EPA defines DES as including pre-kindergarten to grade 12 schools, state-licensed daycare centers, nursing homes, assisted-living facilities, hospitals, inpatient clinics, and prisons. For these sites, no fumigation with a buffer zone greater than 300 feet is permitted within one-quarter mile, unless the DES is unoccupied for 36 hours following the start of the fumigation. For buffer zones of 300 feet or less, the minimum distance from a DES is one-eighth mile.

For the second set of buffer zone requirements, EPA selected buffer zone distances to protect bystanders from exposure to CP. The minimum allowable buffer zone distance is 25 feet. The distances vary based on the product applied, the application rate, the application block size, application equipment and methods, and, if applicable, credits for use of emission-reduction measures such as the use of tarps. Table 1 illustrates these differences by presenting the buffer zone distance requirements for the application of Pic-Clor 60 at 210 lbs/acre, with totally impermeable film (TIF) using two application methods, drip and broadcast, for four field sizes.

Activities are restricted in the buffer zone from the start of the application through a minimum of 48 hours after the application is complete. All non-handlers are excluded from the buffer zone except for purposes of transit, including agricultural workers not involved in the fumigation. If the buffer zones overlap, a minimum of 12 hours must elapse from the end of the first application to the beginning of the second.

In some cases, the buffer can be extended outside the treated field so that all field acreage can be treated. In other cases the buffer cannot extend outside the field, which reduces treated acreage. We refer to the latter case as a "binding" buffer zone. In order to provide a sense of how much acreage can be lost due to binding buffer zones, Table 2 presents the share of field acreage that

Table 1. Buffer Zone Distance by Application Block Size and Treatment Method

Application Block Size (Acres)	EPA Buffer (feet) for TIF Drip	EPA Buffer (feet) for TIF Broadcast
5	25	30
10	45	64
20	78	92
40	132	158

Pic-Clor 60, 201 lbs/ac, Totally Impermeable Film

Table 2. Buffer Zone Acreage and Share of Field Acreage in Buffer Zones

Field Size (acres)	5		10		20		40	
Buffer Zone Width	Buffer Zone Acres	Percent of Field Acres	Buffer Zone Acres	Percent of Field Acres	Buffer Zone Acres	Percent of Field Acres	Buffer Zone Acres	Percent of Field Acres
25	0.3	5%	0.4	4%	0.5	3%	0.8	2%
50	0.5	11%	0.6	8%	1.1	5%	1.5	4%
100	1.1	21%	1.5	15%	2.1	11%	3.0	8%
200	2.1	43%	3.0	30%	4.3	21%	6.1	15%

is part of the buffer and, hence, not part of the application block for a range of field sizes and buffer distances.

Possible Responses to Buffer Zone Regulations

If the buffer zone distance cannot extend outside the field, then the grower has an incentive to reduce it. One response to the buffer zone regulations that growers could elect to pursue is to divide fields into multiple, smaller application blocks in order to qualify for smaller buffer zone distances. Another response would be to treat the same ground multiple times using lower application rates (and perhaps different products) in order to reduce buffer zone distances. However, both actions would extend the period of calendar time required to complete pre-plant soil fumigation of the eligible acreage. This, in turn, can delay planting and, ultimately, harvest. On the other hand, if a buffer zone can extend outside the treated field, there is no reason for a grower to reduce the buffer zone distance further and increase the time required to complete fumigation.

Table 3. Steam Applicator Cost Estimates

Price to Operator	$207,717
Application Rate	15.5 hrs/ac
Equipment Life	7 years
Annual Capital Recovery Cost	$35,573
Annual Repairs	$4,154
Annual Steam Machine Cost/Treated Acre	$253

The extent to which buffer zone regulations reduce strawberry acreage eligible for pre-plant soil fumigation is unknown, but there will be acreage losses in some cases. Growers will have to manage buffer zones. As noted above, there are four basic choices, each with its challenges: fallowing, planting an alternative crop, planting strawberries without fumigating, and treating with a non-chemical alternative to fumigation. We evaluate the economic feasibility of pre-plant soil disinfestation using steam utilizing data from two separate field trials: comparing net returns on a per-acre basis to an untreated control, and comparing net returns on a per-field basis to fallowing the buffer zone or planting strawberries in an untreated buffer zone.

Economic Viability of Steam on a Per-acre Basis

One of the key determinants of economic viability is whether or not pre-plant soil disinfestation using steam provides effective control of pathogens, pests, and weeds. The extent of control influences production costs and yields. A field trial conducted in the 2012–13 growing season evaluated steam's efficacy.

The trial included four strawberry varieties. Different genetic stock may have different levels of tolerance for important pests and pathogens, which in turn, can affect the efficacy of pre-plant soil disinfestation using steam. The varieties included the University of California variety Albion and three proprietary varieties—referred to as P1, P2, and P3 here. Two treatments, steam and steam + mustard seed meal (MS), were applied to each variety and each variety had an untreated control.

Results show that the treatments provided effective control. These results were then used to evaluate the economic returns for the two treatments. Net returns were calculated using *2010 Sample Costs to Produce Strawberries,* cost information regarding the steam applicator (Table 3), and price data from the USDA Agricultural Marketing Service. The average shipping point price for California nonorganic strawberries for flats containing eight 1-lb. containers was $9.99 during the trial period.

Net returns are reported in Table 4. Of the four strawberry varieties, P1 had the highest net return for both treatments and the control. Comparing the treatments, steam yielded the highest return for each strawberry variety. However, net returns varied considerably across the four varieties. This comparison suggests that growers who are considering using steam to treat buffer acreage should consider the performance of varieties when soil is treated with steam, rather than fumigants, prior to planting.

Additional analysis confirms that the net revenues of the treatments are sensitive to the strawberry shipping point price, fuel price, and the speed of the steam applicator. A higher shipping point price, lower fuel price, and faster applications generate higher net profits. The relative importance of variations in these factors depends on yields. Higher yields generate a larger effect on net

Table 4. Net Revenues per Acre

	Steam	Steam+ MSM	Control
Albion	$7,381	$5,395	-$5,231
P1	$10,109	$9,464	-$1,296
P2	$9,349	$8,838	-$3,979
P3	-$2,308	-$4,820	-$4,430

Table 5. Net Revenues by Buffer Zone Treatment: 20-acre Square Field, 78-foot Buffer on One Side	
Buffer Treatment	Field-level Net Revenue
Steam	$10,799
Untreated	$9,752
Fallow	$5,312

revenues for any given change in price.

The non-treated control had negative returns for all varieties. This result suggests that planting strawberries on untreated buffer zones may not be economically attractive.

Buffer Zone Steam Treatment for a Fumigated Field

Apart from its per-acre performance, steam can affect total returns to a field by increasing net revenues, as well as providing better control of pests and pathogens in buffers that cannot be fumigated prior to planting. We illustrate this possibility using the example of a 20-acre square field. Where permitted by regulation, the field is treated with Pic-Clor 60 (56.7% of CP and 37.1% of 1,3-D) through drip application at the application rate of 250 lbs./acre with totally impermeable film.

As reported in Table 1, this treatment requires a 78-foot buffer. In the example, the buffer zone is entirely within the field on one side, so that only 18.33 acres may be fumigated and the 1.67 acres in the buffer zone may not. Data regarding weed control and yield for steam, Pic-Chlor 60, and an untreated control are from a 2010–11 trial near Watsonville, CA.

We compare the field-level net returns for three options for managing the buffer zones: fallowing, planting strawberries without any pre-plant treatment, or planting strawberries using steam for pre-plant soil disinfestation. Results are reported in Table 5.

Treating the buffer with steam prior to planting strawberries results in higher net revenues for the field than not treating the field—approximately $1,000 or around 10% of net revenue. Planting strawberries results in field-level net revenues that are higher than fallowing. The benefit from steam over untreated and/or fallow in the buffer zone for any given field is greater as the buffer zone increases.

Conclusion

The increasing number and complexity of use regulations and associated label restrictions regarding pre-plant soil fumigation increases the challenges associated with managing pest and disease pressure in an economically viable way. Effective buffer zone management is one such challenge. Pre-plant soil disinfestation using steam is one method that can enhance field-level returns for California strawberry production when buffer zone requirements prohibit fumigating some portion of a field.

The use of steam for pre-plant soil disinfestation extends beyond strawberry production. Organic producers can incorporate it into their pest management programs. Much of California's flower production occurs on small fields close to urban areas, even more than in the case for strawberries, so steam can be a part of that industry's response to increased regulation as well. Similarly, there is interest in using steam for golf course renovation.

More broadly, the development of new technology takes years. The regulatory environment is changing much more rapidly. The economically viable uses of steam will almost certainly increase as the technology continues to be improved and regulations become more stringent.

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For additional information, the authors recommend:

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