Weed management on specialty farms

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Southern California farmers use brush covers, wood lath, and kraft paper to promote crop growth (background). Some also use black plastic mulch to "solarize" the soil and kill weeds (foreground).

Farms producing specialty crops in the Lower Colorado Desert generally operate on a limited scale, grow a variety of labor-intensive vegetable crops, and have small capital resources. Crops are usually weeded with hand labor, consuming an inordinate amount of the farmer's time.

Herbicide use on small farms is often impractical for several reasons. One is the lack of technical training and expertise of the farmer, compounded by a lack of pest control advisors willing to service small-acreage accounts. Another is the reluctance of the agrichemical industry to register pesticides for use in minor crops, such as okra, radishes, cherry tomatoes, or eggplant. Those herbicides that are registered fail to provide broad-spectrum control, especially of perennial weeds such as purple nutsedge (*Cyperus rotundus* L.) or bermudagrass (*Cynodon dactylon* [L.] Pers.). Also, with frequent crop rotations, residual herbicides may injure subsequent crops.

We therefore began to evaluate weed management systems that: (1) would provide broad-spectrum weed control; (2) could be used before planting on several different crops; (3) would reduce labor requirements; (4) would enhance crop production; and (5) would be based on easily understood, adoptable technology.

Mulch system

The system would have to be flexible and would include several components, primarily polyethylene plastic row covers (mulches), soil solarization, drip irrigation, and metham or methyl bromide fumigation.

In the Lower Colorado Desert, specialty farmers often use complicated brush covers with wood lath, kraft paper, and south-facing, slanted beds to achieve earlier crops in the spring. Vegetable gardeners and farmers also have used black plastic mulch for years to increase soil temperatures and prevent weed problems.

University of California research on spring-planted cantaloupes in the Imperial Valley in 1980 and 1981 demonstrated the value of plastic mulch for promoting earlier and increased growth. In those experiments, black plastic mulch doubled cantaloupe seedling weight, and clear mulch increased weight by 2½ times because of higher soil temperatures. Without some form of weed control under the clear plastic, however, the weeds eventually out-competed the crop. Clear plastic mulch is used extensively in Israel, along with methyl bromide gas to control weeds and soil pathogens under the mulch. With sufficient weed control, the clear plastic would be preferred for the earliest production in the spring. The plastic mulch layer is applied relatively easily and inexpensively by tractor.

Methyl bromide and metham are broad-spectrum soil biocides that can control weeds under clear plastic. Both have advantages and disadvantages. Methyl bromide is probably the most broad-spectrum, effective biocide in use. It is an extremely toxic gas, however, and requires considerable training and caution in its use. It is also relatively expensive, although the cost can be reduced by treating bed-tops rather than flat ground. For these reasons, methyl bromide is probably not suitable for the very small-scale farmer.

Metham is a liquid that can be broadcast through sprinklers or mechanically incorporated into the soil. Expense is also relatively high, but about half that of methyl bromide. Experiments on metham application through a drip irrigation system underneath plastic mulch have indicated that this method greatly reduces the cost to a figure comparable to a standard preplant incorporated or preemergence herbicide.

Both methyl bromide and metham have other drawbacks: they require precise soil moisture conditions for good results, and some weeds, such as sour clover (*Melilotus indica* [L.] All.), little mallow (*Malva parviflora* L.), and field bindweed (*Convolvulus arvensis* L.), are tolerant enough to build up in fields where these herbicides are used exclusively. Also, the herbicides have to dissipate from the soil before crops can be planted (two to three weeks).

Weed control experiments

In the spring of 1984, we tested three types of plastic mulch: a standard 1-mil clear plastic; Barrier, a plastic treated to prevent gas from escaping as quickly as it does through other plastics; and a black plastic coated with a reflective silver paint. Methyl bromide was applied at a standard rate used commercially (350 pounds per acre) and at two lower rates (150 and 220 pounds per acre) with a tractor-mounted injection system used for treating beds. Metham was injected into the drip irrigation lines after the plastic mulch was in place. Metham rates of 25 and 50 pounds per acre were based on our previous work. The crop was zucchini squash, hand-planted through the mulch one week after the herbicide treatment.

TABLE 1. Zucchini squash vigor and weed control under various chemical and plastic mulch treatments

Chemical and rate*	Plastic	Crop vigor†	Weed control†	
			Purslane‡	Junglerice‡
Methyl bromide:				
350	Silver	8	10	10
350	Clear	10	4.5	5
350	Barrier	10	8.5	10
220	Silver	7	10	10
220	Clear	9	6	10
220	Barrier	10	0	0
150	Silver	6	10	10
150	Clear	5	0	0
150	Barrier	9	7	10
Metham:				
50	Silver	7	7	10
50	Clear	7	10	10
50	Barrier	7	8.5	10
25	Silver	6	10	10
25	Clear	10	9.5	10
25	Barrier	7	5	10
Untreated control	Silver	6	10	10
Untreated control	None	4	0	0

* Rate: methyl bromide in pounds per acre; metham in gallons per acre.
† Rated on a scale of 0 to 10: 0 = no growth (crop vigor) or no weed control; 10 = most vigorous growth or all weeds dead.
‡ Weeds: purslane (*Portulaca oleracea* L.); junglerice (*Echinochloa colonum* L.).

Some of the methyl bromide treatments and one metham treatment did not control weeds (table 1), illustrating the problems associated with the use of these fumigants and the need for precise soil moisture at the time of application. We have discovered that metham, applied through the drip irrigation system, is more consistent in weed control activity.

Drip irrigation has become an important part of the system, because it minimizes stress to the crop by maintaining even moisture and keeping salt away from the roots, and it can be used to apply metham under the plastic mulch. Application of fertilizers or pesticides directly to the crop root zone through drip irrigation reduces waste and environmental contamination. With drip lines under the plastic, only the bed top and root zone are wet, which almost eliminates weeds in the furrows and allows the farmer to harvest and irrigate at the same time. Lastly, the drip irrigation system can be fully or partially automated.

The combination of clear plastic mulch, metham or methyl bromide, and drip irrigation provides a weed management system for spring-planted crops that satisfies the requirements of specialty farms. One advantage of this system is the ability to grow any crop after the application, once the metham or methyl bromide have dissipated.

Soil solarization

In the desert growing areas of California, many vegetables are planted in the fall for winter harvest. Plastic mulches can actually harm the crop at that time of the year by heating the soil too much and killing seeds or injuring young plants by the hot air escaping through the planting holes.

A technique developed several years ago in Israel, however uses this heat to kill weeds and soil pathogens. Now known as soil solarization, it is a simple process of placing clear plastic mulch over moist soil for a period during the summer. Radiation from the sun raises temperatures under the mulch to over 150°F, which kills most weed seeds. In experiments that we have conducted in the Imperial Valley, this process was quite successful in controlling weeds. The longer the plastic was in place, the better the weed control; six weeks was the best (fig. 1).

Soil solarization fits in well with the system because it also satisfies the weed-management criteria mentioned previously. Failures can occur if the soil doesn't acquire enough heat (for example with cloudy days, too short a solarization period, too late a start in the summer, or a layer of dust on the plastic mulch) or if the soil moisture content is too low. By only solarizing beds and using drip irrigation as the moisture source, the farmer can treat in the summer, remove the plastic, and plant without further tractor work. Equipment requirements are the same as in spring plantings. If perennial weeds are a problem, metham can be applied under the plastic during the solarization period.

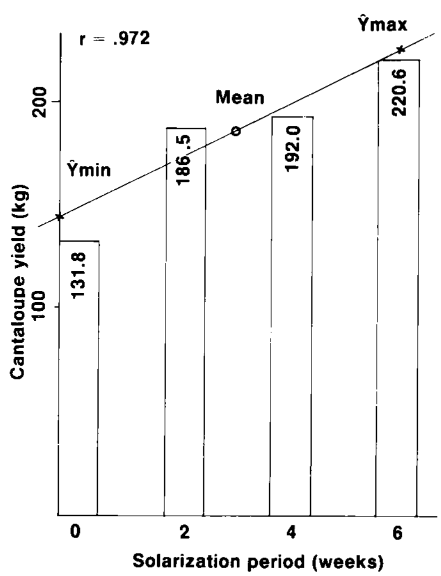

Fig. 1. Solarizing soil for six weeks effectively controlled weeds and substantially increased cantaloupe yields.

Conclusion

Plastic mulches have previously been shown to promote earlier, increased growth. The farmer can also manage weeds by using nontransparent plastic, which excludes light and inhibits weed germination, or using methyl bromide or metham as broad-spectrum soil biocides to eliminate weeds under a clear mulch. For fall-planted crops, soil solarization, a nonpesticide treatment, may control weeds under a clear plastic mulch. Drip irrigation, in addition to its benefits in water management, enhances weed control by confining irrigation water to the soil under the mulch and allowing the grower to apply metham easily and safely.

At present, we know of several small-scale farmers in the Imperial and Coachella valleys who are successfully using parts of the system in vegetable production. Detailed cost information is not available, however. This system is relatively expensive (for example $150 to $250 per acre for mulch, $100 to $300 per acre for metham), but so is hand labor for weeding and setting up brush covers to promote earliness (about $1,000 per acre). Future research will concentrate on the economics of this type of crop production.

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