Solarization: an Environmentally Friendly Technology for Weed Control

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Abstract

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Weeds are present as seeds or propagules in the soil at the time of crop planting. As the crop establishes, weeds also grow unless they are controlled. The greatest weed competition occurs in the first 4 weeks of establishment. As mechanical seeding and cultivation increases, weeds must be controlled in the seed-line. Soil solarization has been an effective method of weed control for most weed species. It has been especially effective on *Orobanche* sp. and Asteraceae family species that chemicals have not adequately controlled. Winter annual species are all easily controlled. Only some summer annuals and some perennials with deep rhizomes or rootstocks are not controlled. Benefits of using soil solarization for weed control include 1) broad spectrum pest control, 2) do not need specific chemicals, rates, or chemical application equipment, 3) no concern about over application and thus crop residues, 4) no concern about chemical residues in the soil, 5) plantings of many crops in a small area, without potential herbicide contamination from one crop to another, 6) can be applied by hand or machine, and 7) may "clean up" a site of a major pest complex without using several chemicals. Soil preparation and application techniques should be stressed for optimum weed control to enhance the acceptance of this environmentally friendly method of pest control.

Key words: Weed control, soil solarization, IPM, Orobanche.

Soil solarization or sometimes called soil pasteurization has had a short but interesting history. It has been researched to determine how to make it work successfully in various parts of the world. The pest management method has also been used by some farmers because they are interested in the technique. They think that is easy to use, environmentally and humanly safe, and it should be successful. There have been advantages of costs over the where previously it was unable to grow because of pests, increased pest control and increased yields of crops after solarization.

Solarization can give a broad spectrum of weed control (2, 3, 4, 8, 9, 10). There is some weed selectivity but it is probably not going to be used to an advantage. Annual crop plants have to be planted after the solarization is completed, though perennial crops can be treated. Solarization has been evaluated successfully in many countries (4). In these tests, winter annual weeds have been controlled in almost all studies (4). Summer annual species have generally been controlled with some exceptions being *Melilotus* sp., *Portulaca oleracea*, *Scorpiurus luteum*, *Coronilla scorpoides* and *Conyza canadensis*. Control of some summer or heat tolerant species have been more variable. Weed susceptibility is more narrow and the care in solarizing to make sure that the correct conditions are present will make a greater difference in success. Perennial species such as *Cynodon dactylon* and *Sorghum halapense* have generally been controlled (5), however, in some studies regrowth became the dominate weed (9). Other perennial species like *Convolvulus arvensis, Imperata cylindrica, Cyperus esculentus* and *C. rotundus* have not been controlled. Parasitic species such as *Orabanche* sp. have been successfully controlled although not eradicated (1, 9).

Successful solarization will take into account all management practices. Soil moisture before and at the time of solarization will improve weed control. Seeds start to imbibe water and are easier to kill in moist soil. Solarization during the period of maximum radiation is critical for control. This may not be the middle of the summer months, particularly along coastal regions. If solarization is planned for beds then the beds should be oriented north to south to take advantage of the uniforming warming of the bed, rather than a cool and warm side. Keeping the tarp intact for the duration of solarization can also sometimes be a problem, especially if there are animals around to puncture the plastic. All of these factors can determine the success of the application.

Solarization is not limited to any one crop or type of cropping system. It can be used in row crops, field crops, young orchards or shrub crops or for potting mixes (6) being reclaimed or prepared for planting. In crops where no herbicides are registered it is an opportunity to achieve broad spectrum pest control without concern for crop damage. Some who have not evaluated solarization feel that it is a technique only for high value crops. In high value crops, this safe technology should be the primary method of preplant weed control but it need not be limited to high value crops.

When soil solarization was first described using plastic technology it was an evolution from fumigation with methyl bromide. The evolution gave a technique that has much of the same benefits without the hazard of working with a toxic material. Methyl bromide is being closely scrutinized because of its potential hazard to the ozone layer and ground water (11). It is well known as being toxic to applicators. This is a known hazard and as more people use the product more people are exposed. Solarization has also been compared for effectiveness with metam sodium. Solarization has been as effective as metam sodium on most weeds, though not as effective on some deep pathogens (7). Combining solarization with metam sodium at one-quarter to one-half rates of application has given similar control as metam sodium alone at full rates (7). In most studies metam sodium has not been as effective on, difficult to control pests, as methyl bromide, but it is safer to use. Because of the safety afforded from soil solarization, it should have become a standard practice by now, yet it has not.

Soil solarization is easy to use. It is also easy to make an application with less than the required conditions, thus it may not always work successfully. The materials for successful solarization for weed control are easy to obtain. If one surveys the literature, studies vary with different results on the same weed species. In evaluating common purslane control results varied from excellent control to poor control. Why should this occur? It could be because of moisture differences in soil between studies, poor radiation conditions at some sites, different polyethylene thicknesses or phototransmission qualities, maybe there were holes in the plastic or there could be a different common purslane biotype. A student recently completed a thesis showing that plants collected from six areas ranging in mean summer temperature from 15.5 to 30.9C did not show a correlation with control and temperature. There was a strong relationship between temperature and duration of temperature and control.

There are distinct benefits from solarization. There are environmental and sociological reasons for it use (11). There is not a potential for pollution from an application. There is no residue of a pesticide left in the soil. This allows a planting of any crop without concern of a herbicide carryover, or a concern of a residue in the following food crop. Perception of a safer treatment by not having a pesticide residue also allows for an increased price of a commodity or opportunity to sell or ship a commodity, that if treated with some pesticides would not be accepted. It is safe to apply. Relatively poorly trained workers can still apply plastic without concern by the farmer that a worker might be injured. Solarization can give longer term results on some pests than a single application of a pesticide. Solarization tends to be nonselective on weeds, thus it may save applications of one or more selective herbicides to achieve the same control. In some crops two or more selective herbicides are used to control different weed species.

Solarization has not been as widely used as it could be because of several reasons. First, as long as methyl bromide is available, better, more consistent control can be achieved of most pests by methyl bromide. Unlike methyl bromide, solarization requires taking land out of production for a period that in some areas will reduce the cropping period. For most of the world, particularly in the United States, there is no recycling of the polyethylene, thus it becomes a waste problem. This has been a deterrent to its use. Solarization has not been as dependable as methyl bromide for weed control. There have been instances where application gave less than excellent control. Putting all of these reasons together, the technique has not been widely accepted and used.

الملخص

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توجد الأعشاب في التربة على هيئة بذور أو أجزاء تكاثرية عند موعد الزراعة. ومع استرساء المحصول، تنمو بذور الأعشاب ما لم تتم مكافحتها. وتحدث المنافسة العظمى للمحصول في الأسابيع الأربعة الأولى من استرساء المحصول. وبما أن البذر الآلي والفلاحات تزيد من الأعشاب، لذا يجب مكافحة هذه الأخيرة في خطوط البذر. وقد وجد أن تشميس التربة طريقة فاعلة لمكافحة معظم أنواع الأعشاب. وكانت فاعلة، على نحو خاص، لمكافحة الهالوك وأنواع من الفصيلة النجمية التي أخفقت المبيدات الكيميائية في مكافحتها بشكل كاف. وبإمكان هذه الطريقة مكافحة كافة الأعشاب الحولية الشتوية بسهولة، على أنها لاتكافح بعض الحوليات الصيفية وبعض الأعشاب المعمرة ذات الجذامير والجذور العميقة. وتشمل مزايا تشميس التربة لمكافحة الأعشاب: 1) مكافحة طيف واسع من الآفات، 2) لاتحتاج إلى كيماويات نوعية أو معدات مكافحة، 3) قلة المخاطر الناجمة من زيادة الجرعات وبالتالي الآثار المتبقية في المحصول، 4) قلة المخاطر الناجمة من الآثار المتبقية للمبيدات في التربة، 5) زراعة عدة محاصيل في منطقة صغيرة، دون الخوف من انجراف المبيدات العشبية من محصول لآخر، 6) يمكن تطبيقها يدوياً أو آلياً، 7) تستطيع "تنظيف" الموقع من معقدات الآفات دون الحاجة لإستخدام كيماويات متنوعة. ولابد من التأكيد على ضرورة عمليات تحضير التربة والإستخدام للوصول إلى مكافحة فضلى للأعشاب بغية زيادة قبول هذه التقنية الأمينة بيئياً لمكافحة الآفات.

كلمات مفتاحية: مكافحة أعشاب، تشميس التربة، إدارة متكاملة للآفات، الهالوك.

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