THE STALE SEEDBED TECHNIQUE: A RELATIVELY UNDERUSED ALTERNATIVE WEED MANAGEMENT TACTIC FOR VEGETABLE PRODUCTION

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Background problem
Weed management in vegetable cropping systems typically consists of crop rotation, manual weeding, weed mats, herbicides, and cultivation. Herbicide options in conventional and organically grown vegetables are limited because of infrequent registration of new herbicides and product loss due to regulatory actions. Further, vegetable crops are sensitive to many herbicides and this limits the number of products that can be safely applied. The list of organic herbicides is especially limited and there are no pre-emergent organically registered herbicides to prevent weed seed germination. In addition, organic herbicides are mostly unaffordable for commercial vegetable production if sprayed over the entire field. Cultivation has its limits because while weeds between crop rows can be managed with cultivation in some cropping systems, weeds within crop rows generally escape cultivation. Crop rotation is an important weed management practice but is only effective when integrated with other weed management tactics. Manual weeding is effective for organic producers but is costly and one of the most labor intensive production practices.

An often overlooked weed management practice is the stale seedbed technique; a weed management practice in which weed seeds just below the soil surface are allowed to germinate and then killed prior to planting the cash crop while minimizing soil disturbances. The stale seedbed technique is based on the premise that weeds which germinate and emerge before the crop is planted are easier to manage. Ideally when using this technique, only the seeding or transplanting operation should be responsible for disturbing the soil. Some researchers have suggested that stale seedbed weed management is critical to maximize yields of crops that have limited herbicide options. If implemented correctly, the stale seedbed weed management tactic may have a positive impact on vegetable production because it does not depend on new herbicide registrations or require equipment not commonly used in vegetable production. This weed
management option can be adopted by organic and conventional growers and has the potential to reduce herbicide use, hand-labor, and overall weed management cost.

**Precisely how does the stale seedbed works?**

It has been stated that the stale seedbed technique is based on three principles: 1) cultivation promotes weed seed germination, 2) a small percentage of weed seeds in the soil is non-dormant and able to germinate at any given time and those that can, mostly germinate quickly, and 3) the vast majority of weeds only emerge from seeds in the shallow layer of the soil (i.e., top 2.5 inches), and most typically emerge only in significant numbers from the top one inch of the soil. Stale seedbed works by targeting weed seeds in the shallow layer (i.e., germination zone) of the soil. These nondormant seeds are allowed to germinate and then killed just prior to planting the cash crop. Non-dormant seeds have the capacity to germinate over a wide range of normal physical environmental factors, as opposed to dormant seeds which will not germinate until a specified period of time has passed, even when conditions are favorable for their germination. Weed emergence from the germination zone depends on weed species, soil type and physical characteristics, as well as prior land management practices. When adequate moisture is available, most weeds found on crop land emerge from the top 2.5 inches of the soil profile. Therefore, the stale seedbed technique works by depleting shallow “germinable” weed seeds that would normally develop and compete with a crop after it is planted. This technique works especially well if these shallow weed seeds germinate just prior to crop planting or during the early period of the crop cycle while germinable weed seeds at deeper depths remain undisturbed. Although weed emergence stimulated by irrigation and other production practices is often thought to complicate weed management efforts, this intentional or forced germination may be used as a valuable weed suppression tool.

**What practices can be used to kill weed flushes during stale seedbeds?**

Once weeds are flushed several methods may be used to kill emerged weeds and complete the stale seedbed technique. In reality, methods that minimize soil disturbances and associated movement of dormant seeds
from deeper depth of the soil into the germination zone are ideal choices. Herbicide sprays are generally used as part of stale seedbed practices because of minimum soil disturbances during herbicide applications. Other products such as flamers and shallow tillage equipment may be used to control emerged weeds. If cultivation is used to kill weeds that are flushed during stale seedbed practices, it must involve the minimum depth of tillage necessary to kill all emerged weeds but must be less than 2.5 inches so as not to bring up more weed seeds that will then germinate during the crop growing season. In spinach, it was shown that weed control levels achieved with two “no-disturbance” techniques (herbicide and flamer) were generally better than with techniques that disturbed the soil (e.g., rotary cultivator and hoe, top knives, etc.). However, in a separate study, it was found that shallow cultivation was more effective than glyphosate for weed management in cucumbers and peanuts.

Not all tillage operations facilitate the stale seedbed technique equally. For example, one study indicated that peanut yields tended to be higher with shallow tillage than no-tillage stale seedbed technique. Timing and chemical makeup of herbicides are additional factors that are critical for optimizing their weed suppressive potential via stale seedbed. For example, researchers found during a no-till pumpkin study that paraquat provided better broadleaf weed control than glyphosate as part of a stale seedbed practice and this led to improved pumpkin yield. Further, it was suggested that applying paraquat in no-till pumpkin before it starts vining is warranted to control weeds that may emerge later in the growing season.

What are some disadvantages of the stale seedbed technique?

Though the stale seedbed technique can be effective, like any weed management tactic there are some drawbacks. Weeds with lengthy emergence periods may not be managed as well with this technique. Soil conditions such as moisture and temperature affect weed emergence and these factors cannot be controlled. For example, in the absence of adequate rainfall, fields may require pre-irrigation events to initiate weed flushes. Finally, under certain conditions, especially when dealing with “wimpy” or less competitive (e.g., small and slow growing) crops, multiple weed flushes over time may be required before planting the crop to effectively prevent weeds from competing with the crop after planting. Because the standing weed seed bank and soil conditions will differ from field to field, the optimal waiting period
between pre-plant irrigation and final killing of weeds may not be known. The stale seedbed technique can be initiated several days, weeks, or months prior to seeding or transplanting a crop. A study involving cucumbers indicated that the optimal timing of stale seedbed preparation was 20 to 30 days before planting. If tillage is used to kill weeds that are flushed during stale seedbed techniques, this could result in more weed seeds being brought up to the soil surface. Stale seedbed technique should not be viewed as a stand-alone treatment that maintains weed suppression during the entire cropping cycle and thus may often require it be part of an integrated weed management (IWM) program.

Will there be research on this technique in Maryland or neighboring states?
University of Maryland (UMD) researchers Amanda Buchanan, Guihua Chen and Cerruti Hooks along with colleagues at University of Maryland Eastern Shore, University of Delaware, and Delaware State University submitted a research grant to an USDA granting agency to investigate the use of the stale seedbed tactic in combination with one or more of the following practices: winter cover cropping, strip-tilling, no-till planting, flail mowing, in-row cultivation and herbicide application. If funded, we hope to develop a truly integrated IWM program for conventional and organic vegetable producers. In addition, Amanda, Guihua and Cerruti will establish demonstration plots at the Wye Research and Education Facility to show the potential use of the stale seedbed technique in combination with winter cover crops and several cover crop suppression methods such as flail mowing, herbicide burn-down, and roller crimper.

Summary
Stale seed bed is a relatively simple weed management tactic that generally involves four steps: 1) a seedbed is prepared, 2) weed seeds in the shallow soil zone germinate naturally or via pre-irrigation and then emerge, 3) emerged weeds are then killed with minimum soil disturbance as necessary, and 4) the crop is promptly seeded or transplanted into mostly weed free soil. A variety of organically acceptable and conventional methods can be used to establish stale seedbeds. Protocols that encourage the greatest amount of “weed flush” without disturbing the soil generally will result in fewer weeds germinating and competing with the cash crop after it is planted. Though the stale seedbed tactic has shown great potential as a weed management option, and may be especially useful in vegetable systems that compete poorly with
weeds during the initial period of crop emergence, this technique may require integration with other weed management tactics for season-long weed suppression. For example, the use of an effective stale seedbed technique in combination with cover crop residues may suppress weed development for an entire vegetable cropping cycle. Clearly, improvements in vegetable crop weed management are needed and will depend on refining current tactics and integrating these tactics into a more sustainable and economically feasible system. The stale seedbed technique is a cultural practice that shows great potential as a viable component of an IWM program for conventional and organic vegetable systems, and if properly orchestrated can improve weed control while lowering herbicide applications and overall production cost.