Seedbank Management

Managing Weeds through Germination, Preemption, Predation, and Flaming

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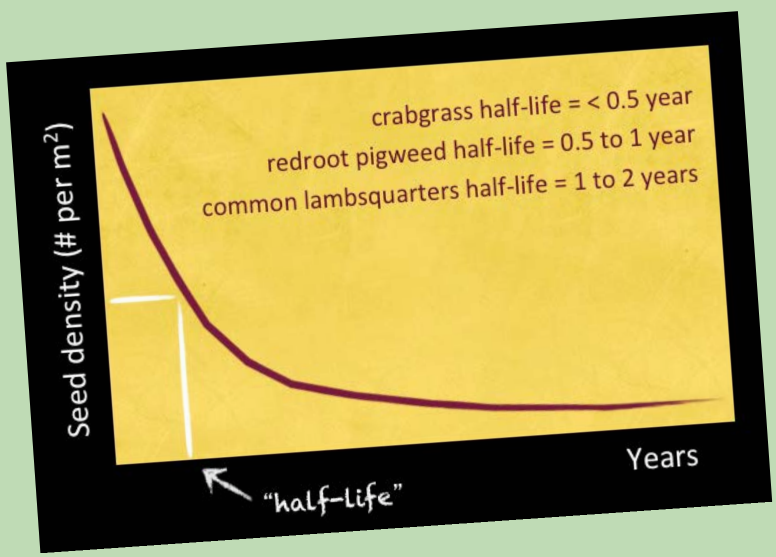
Farmers commonly focus their weed management efforts during the 'critical weed-free period' at the beginning of each growing season. While effective for minimizing yield losses, this focus often allows missed or late-germinating weeds to go to seed, resulting in a recurring weed problem. Intentional management of the weed seedbank to maximize seed 'debits' and minimize 'credits' can help farmers reduce their long-term weed pressure. Practices that can contribute to effective seedbank management include stimulating seed germination, preempting seed rain, supporting seed predation, and seed flaming.

Germination

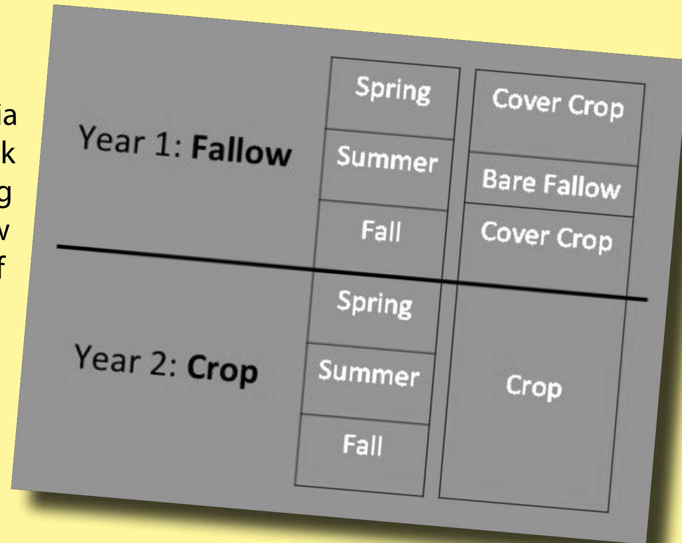
Germination is the most effective means of removing seeds already present in the seedbank. Many weed seeds have complicated dormancy mechanisms, which may allow them to persist in the seedbank for decades.[1] Agricultural weeds, however, tend to be highly adapted to frequently disturbed environments. Consequently, disturbance events such as tillage often provide the impetus needed to break seed dormancy, promoting a 'flush' of weed

Box 1: Seed 'Half-Life'

A seed's 'half-life' is the amount of time it takes half of the seeds of a particular species present in the seedbank to die. Half-life varies by species but is typically less than two years in tilled soil.[1] Thus, if no new weed seeds enter the seedbank, the total number of seeds present will decay exponentially over time.



Box 2: A Case Study in Crop Rotation



Anne and Eric Nordell of Trout Run, Pennsylvania use a two year crop rotation designed for seedbank management.[2] In Year 1, they plant a spring cover crop. They follow this with a bare fallow period timed to coincide with peak emergence of whichever weed species they are most interested in controlling that year. They create a "stale seedbed" by repeatedly rolling with a cultipacker to stimulate germination, then shallowly tilling to kill emerged weed seedlings. This bare fallow period is followed by a second cover crop. The cover crops improve soil quality, compensating for the toll frequent tillage takes on their soil. By intentionally managing their seedbank, the Nordells keep their weed pressure low so that the two of them (and a team of horses) are able to farm their 6 acres without hiring additional help.

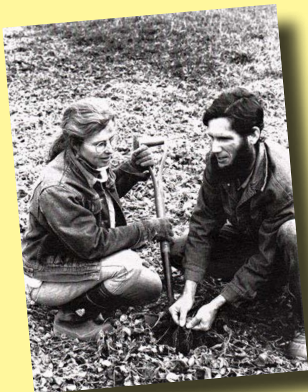


Photo: www.mofga.org

emergence. In tillage-based agricultural systems, seeds are lost from the seedbank at an exponential rate (**Box 1**), so that only a small fraction of seeds entering the seedbank persist in the soil for the 'worst case scenario'—their longest and hardiest dormancy.

Summer fallow periods, during which the soil is disturbed every few weeks, can be an effective means of rapidly depleting the seedbank, promoting weed germination, then killing each emerging cohort of weed seedlings (**Box 2**).

Seed Rain Preemption

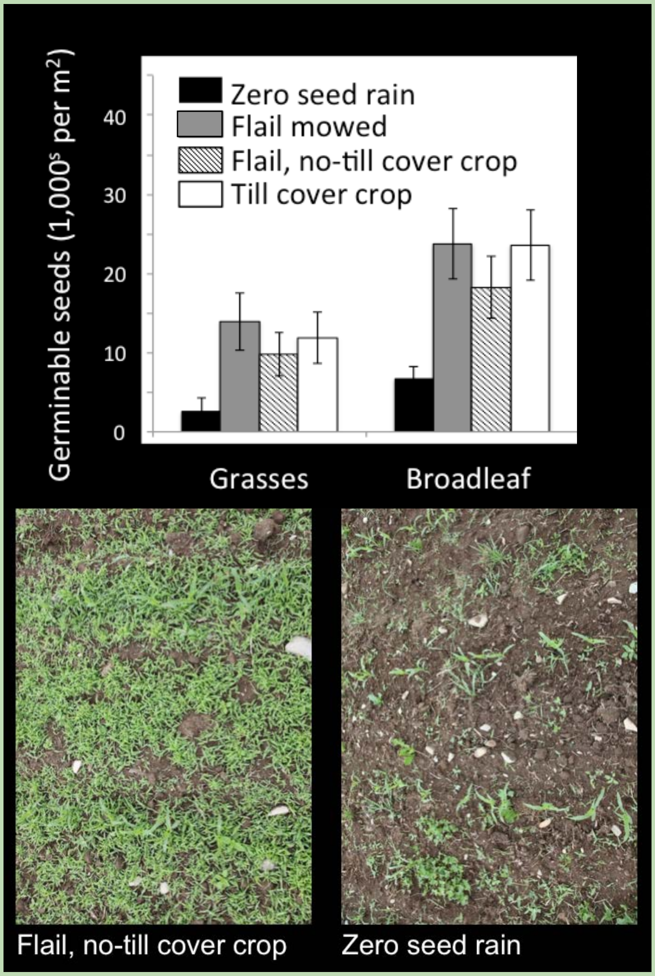
Numerous tactics can help the farmer preempt, or minimize, seed rain. Meticulous and timely weed control aimed at achieving 'zero seed rain' is one such preemption strategy. While the hand weeding effort needed to achieve this high level of control may be labor-intensive and costly in the short term, our research shows that just one season of managing for zero seed rain can substantially deplete the weed seedbank (**Box 3**). Thus, this kind of intensive management can be thought of as a long-term investment, in which one season's effort paves the way for a sustained reduction in weed pressure.

Seed rain can also be preempted through strategic planting, irrigation, and fertilization practices. Because weeds compete with crop plants for space, light, water, and nutrients, practices which provide the crop with a competitive edge can reduce the size of weeds, and the quantity of seed they can produce. Planting competitive crop varieties, minimizing space between crop plants, and over-seeding grains and cover crops are all strategies that can help optimize crop competitiveness and 'crowd out' weeds.[3] Using drip irrigation and selectively applying fertilizer in crop rows but not inter-row spaces can similarly increase crop competitiveness by preventing weeds from utilizing these resources intended for the crop.[4]

Seed Predation

Seed predators common in agricultural systems include

Box 3: Seed Rain Experiment



Methods

We studied the effect of four post-harvest field treatments on the weed seedbank at the Rogers Farm in Stillwater, Maine. The treatments were:

1. 'Zero seed rain,' in which plots were exhaustively hand-weeded for total weed control
2. Flail mowed and left to rest
3. Flail mowed and no-till planted to a cover crop
4. Tilled and planted to a cover crop

The next spring, we measured the number of weed seeds in the seedbank by exhaustively germinating soil samples from each treated area, and counting number of emerged weed seedlings.

Results

There was a significant seedbank reduction in both grasses and broadleaf weeds in the 'zero seed rain' plots as compared with other treatments, as shown in the graph and images at left.

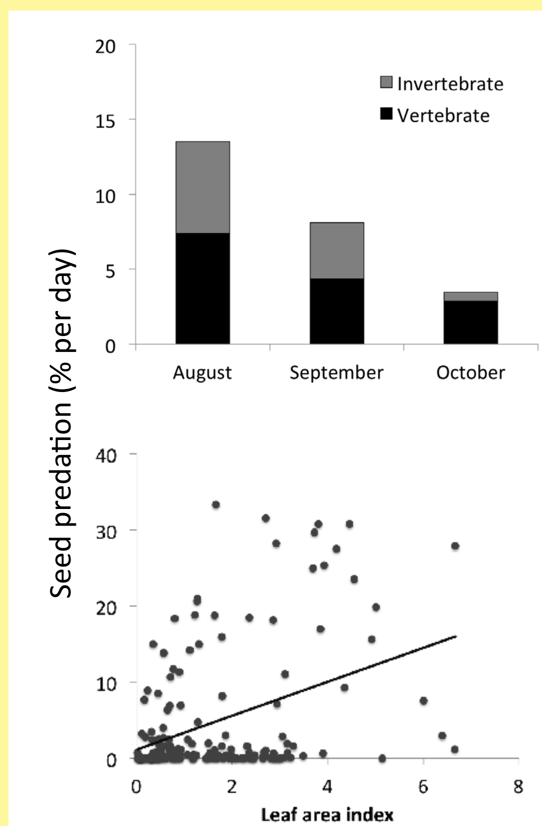
Box 4: Seed Predation Experiment

Methods

We used seed assays (dishes on which a known number of seeds were placed) to measure weed seed predation in crop and non-crop habitats at Peacemeal Farm in Dixmont, Maine in the fall of 2012.

Results

Total seed predation averaged 8% per day. Seed predation decreased from August to October, especially among invertebrates (insects), as shown in the upper graph at right. Within crop fields, sites with greater 'leaf area index' (more vegetative cover) supported higher rates of seed predation, as shown in the lower graph at right. The ground beetle *Harpalus rufipes*, pictured at left, is a dominant seed predator on Maine farms.



mice and other small mammals, birds, and insects such as ants and ground beetles. These animals typically forage for seeds on the soil surface, and therefore pose little threat to buried crop seeds. Seed predation may be substantial, but is variable over time and between sites (**Box 4**).

Cover cropping may support seed predator populations and encourage foraging, particularly of mice and ground beetles. Presence of forest or wetland habitat near crop fields may support seed predation by providing desirable habitat for birds and small mammals. Seed predators remain active well into the fall in temperate agroecosystems. Thus, in fields where seed rain has already occurred, delaying fall tillage may allow seed predators to find and eliminate seeds from the soil surface, reducing seedbank inputs. However, since seed predation is unpredictable, preventing seed rain is recommended over relying on seed predators whenever possible.

Seed Flaming

Flaming is widely used to kill small seedlings, but can also effectively kill weed seeds present on the soil surface after seed rain (**Box 5**). However, slow tractor speeds (and therefore high propane inputs) are necessary to achieve high levels of weed seed mortality.

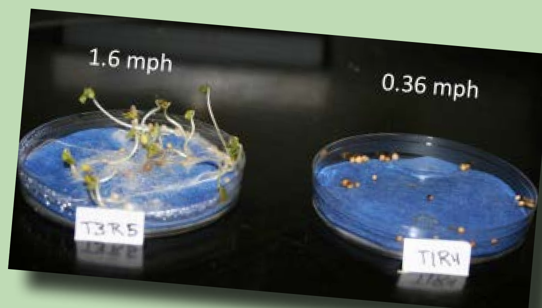
Box 5: Seed Flaming Experiment

Methods

We conducted experiments at Goranson Farm in Dresden, Maine and Pete's Greens in Craftsbury, Vermont to test the effects of tractor speed on weed seed death during flaming.

There were four experimental treatments:

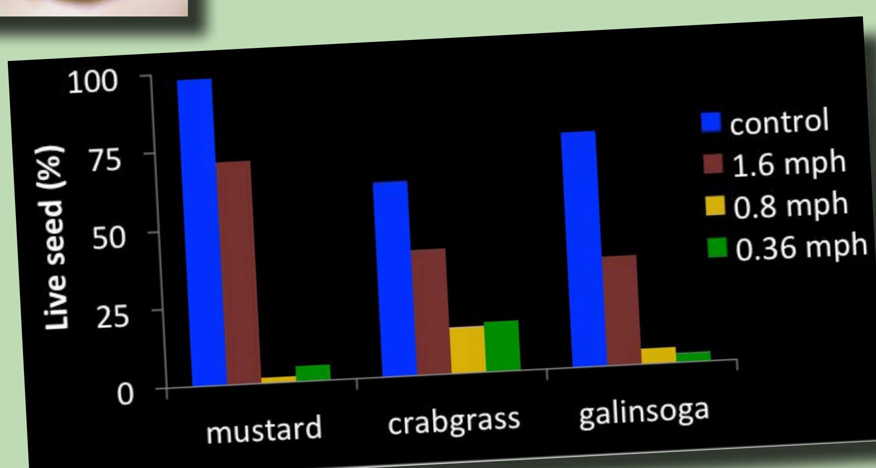
1. One flaming pass at 1.6 mph
2. One flaming pass at 0.8 mph
3. One flaming pass at 0.36 mph
4. Control (seeds not exposed to flaming)



After flaming, seeds were germinated in the lab, as shown in the image at right.

Results

As shown in the graph below, when the tractor was run at speeds slower than 0.8 mph, flaming killed a high percentage of seeds of all three weed species tested. Flaming at 1.6 mph was also fairly effective against hairy galinsoga, resulting in 50% mortality as compared with the control. Seeds in the 0.8 and 0.36 mph treatments were often visibly charred, or 'popped,' as pictured at left.



Conclusions

The seedbank can be successfully managed through practices such as stimulating weed seed germination, preempting seed rain, supporting seed predation, and seed flaming. Germination and seed rain preemption reliably reduce weed pressure (**Box 3**). Seed predation is unpredictable, but can be very important (**Box 4**), and flaming can kill seeds, but propane dose requirements are quite high (**Box 5**).

Learn more at...

umaine.edu/weedecology

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