

## **Weed Control Strategies at Fort Hill Farm**

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Fort Hill Farm is a 20 acre certified organic farm producing primarily vegetables, along with smaller crops of herbs, strawberries, cut flowers, and melons. Access to land is difficult in southern New England, and we generally grow horticultural crops on nearly all of the 16 arable acres that we rent from Sunny Valley Preserve, a project of The Nature Conservancy. The farm's first production year was 2003. For 2008, our markets include a 400 share CSA, a farmers market, and a few wholesale accounts. Our soil is Copake sandy loam.

When I arrived at Fort Hill in the fall of 2002, the entire farm was in a solid hay stand of orchardgrass that was over 10 years old, and had a very low weed seed bank of broadleaf annual weeds. There was a moderate bank of crabgrass seed. On most organic farms, broad leaved weeds like pigweed, lambs quarters, and hairy galinsoga are very problematic weeds. I have tried very hard to keep the soil seed bank of broadleaf weeds to low levels, and to avoid soil conditions that promote the germination and growth of annual grasses.

Our weed control system is tightly bound to our soil fertility system. We have an active on-farm composting program utilizing heavily bedded horse manure, and leaves dumped by local landscape contractors. Compost piles are turned as needed to promote heating to kill weed seeds, and to prevent weeds from growing on the piles. Our compost has only moderate levels of available nitrogen, and often does not conform to the USDA definition of compost. Therefore we spread compost in late summer before vetch and rye green manure, or in the spring before pea and oat green manure. Fall planted, winter annual cover crops are usually weed free. Large seeded, spring planted cover crops such as peas often have large amounts of summer annual weeds, but they are mowed and incorporated before the weeds go to seed. Composting and cover cropping are necessary to maintain high levels of organic matter, which is necessary to counteract the negative effects of frequent cultivation often used in organic production systems.

I have found it useful to take a number of different approaches to weed control. We have a farm policy to try to never let broadleaf weeds go to seed, although we sometimes tolerate the presence of weeds in a crop if they will not set mature seed before the crop is harvested, and will not affect crop yield or quality. We try to immediately flail mow all harvested beds and any immature weeds that they contain. In crops like winter squash where it becomes physically impossible to remove weeds from a maturing crop, or in beds where we goofed and let broadleaf weeds mature, we physically remove weeds with viable seed after we have harvested the crop. When one considers that large pigweed plants are reported to produce upwards of 250,000 seeds that can survive several years in the soil, the time taken to remove them in one shot seems to be a good investment.

We have two field production systems. Most crops are grown in bare soil on a flat bed, five feet wide. These crops are mechanically cultivated. We also mulch a number of crops, including tomatoes, peppers, eggplant, and melons. These crops are grown on a six foot bed and planted into plastic mulch. We then mulch these beds with round bales rolled down the aisles between crops. We also mulch our garlic with fall leaves, covered with a light layer of straw to hold the leaves in place. We leave this mulch in place to conserve water and limit weed growth throughout the life cycle of the crop

For crops where we intend to use mechanical cultivation, we rely heavily on stale seedbeds. A completely flat planting surface is necessary to fully utilize this technique. We generally prepare our beds by first spading with an older Imants rotary spader. Our five foot beds (center to center of rear tires) are cut as fertilizer is applied to the beds. (Purchased fertilizer generally accounts for about a third of our crop nutrient needs). We wait for, or expedite, the germination of weed seeds. We then cultivate the beds with a Buddingh basket weeder, with baskets over the entire planting surface, mounted to an IH 140. We run this cultivator only deep enough to kill the emerging weeds, and try hard not to go so deep as to bring up ungerminated weed seeds. Generally this means cultivating no deeper than one inch below the soil surface, or more shallow if possible..

While the equipment for stale seedbed technique is relatively straightforward, I have found that a good understanding of weed seed germination is necessary to get the best results. It is critical that the beds experience the environmental conditions necessary to germinate the most competitive weeds present in the field, prior to basket weeding. In our case, the most competitive weeds are usually pigweed and crabgrass. Both of these weed species respond to warm, fertile soil that has been disturbed, and then settled by a rain or irrigation. Once we have tilled and set up the beds, if there is no rain in the forecast we use overhead irrigation from a traveling gun to germinate the weeds. We will also delay planting until the soil has warmed sufficiently to germinate weed seeds. In the case of a crop like winter squash or early sweet corn, we will sow the seeds in a greenhouse while the intended planting field is in the stale bed process, to ensure that the crop matures on time. In spring planted beds where we will apply row covers, we apply the row cover after forming the beds but *before* seeding our crop, irrigate if necessary, and wait a few days for some warm sunny weather to pop the weeds before cultivating with the basket weeder. Only then do we seed the bed. On our farm, applying row covers to seeded beds which have not been pre-germinated/basket weeded is a recipe for epic stands of crabgrass, a weed that loves to germinate in the hot soil conditions often encountered under row cover. The few days we lose waiting for the weeds to germinate are a small price to pay to greatly reduce costly hand weeding.

Stale seed bedding allows us to kill most of the weeds in our beds before we plant, and is by far the most effective weed control technique we have available to us on our farm. Unfortunately, it is not 100% effective. Sometimes weather, operator error, or equipment problems can force a grower into planting into beds that were not properly staled. In this case, the weeds will germinate with the crop. We have several cultivation tools that help us kill weeds that germinate with the crop. When using cultivation tools, I feel the most important thing is to use the tool which will bring up the least amount of ungerminated weed seeds. Because we rotate about 40 different crops through our fields,

it is critical that we not let the weed seeds in this years winter squash become a mess when we plant salad mix in a future year. To cultivate out weeds which have germinated with a crop, we use a tine weeder, a three row Buddingh basket weeder, a finger weeder, and several types of hillers. I generally use sweeps only as track eradicators. When used in the bed, I find they work the soil too deeply, and bring up weed seeds which will grow under the crop canopy and eventually set seed.

Tine weeders have thin metal tines which vibrate to break the soil surface and expose thread weeds to dry and die in the sun. They can be used as a blind cultivator, dragged over all surfaces of a bed, on large seeded crops like corn, beans, and peas. The best time to do this is after the crop root is established, but before the hypocotyl (the stem below the cotyledons) has begun to elongate. A tine weeder is most lethal to very small weeds, and vigilance is required to drag the beds while the weeds are in the white thread stage. Tine weeders can also be used over transplants. It is critical that the transplants be well established so that the weeder doesn't pull them out. I determine this by giving the transplant the 'tug test': if a slight tug uproots the seedling, I either lift the tines over the row, or use a basket weeder instead. I find the ability to lift individual tines very useful, as you can decrease or increase the aggressiveness of the cultivator over different parts of a bed. By lifting the tines over the row, we are able to tine weed large crops such as winter squash just before the vines run.

We also have a three row basket weeder, which runs at the same row distance as our seeders and transplanter (3 rows, 14 inches apart). This means that we never have to change the spacing of the basket weeder, and allows it to be used on any crop under four inches tall. This three row basket weeder is one of our most important cultivation tools. We use it to cultivate extremely small crops like newly emerged carrots and beets, and transplants which do not pass the 'tug test' for tine weeding. A flat bed is important, as weeds germinating in dips in the bed will not be killed. As with all cultivators, optimal operating speed and operating distance from the crop need to be determined by trial and error.

We also sparingly use hillers. We have a set of disk hillers which we mount on an Allis Chalmers G to hill potatoes. Occasionally we will use this set up to hill fast growing crops like corn, or transplanted brassica crops. Hillers can bury large weeds and greatly reduce hoeing and hand pulling. The downside is that by nature, they work the soil deeply and can bring up a large amount of ungerminated weed seed which can set seed and cause problems in future years. They work best on crops which will quickly produce a shade canopy and provide competition against weed growth. We have a second type of hiller which is a flat rectangle mounted on a shank. This hiller is very useful for burying weeds around transplants that have been set with a transplanter with press wheels. I find it particularly useful for the first or second cultivation of strawberry transplants, as it is almost impossible to stale bed early spring strawberry plantings.

We use a Buddingh finger weeder on onions and strawberries. Both these crops are week competitors against weeds, and challenging to grow in organic farming systems. The finger weeder is mounted on an Allis Chalmers G, either offset to weed a row of onions (planted 2 rows to a five foot bed) or a single row of strawberries. Finger weeders can remove some fairly large weeds, and reduce the time needed for hand pulling or hoeing.