



Turn-the-Page Weed Management Compared to Conventional Herbicide Use in Greenhouses

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Introduction

Growing crops in insect exclusion greenhouses has shown promising results to protect certain crops from insect pests that are otherwise difficult to manage using conventional pesticides. For example, zucchini yield was 4.8 times higher in the greenhouse compared to that grown in the open field (Ching et al., 2016; Wang et al., 2017). Unfortunately, greenhouse crop production has several challenges especially if the greenhouse is small without a large door. Limited space within the greenhouse is a problem for organic producers who rely on mechanical weed management. With the greenhouse structure installed, farmers will be restricted to use hand-held rotovator or a weed whacker, which is more labor intensive than tractor driven rototillers. Some farmers choose to cover the entire house with weed mat. We are proposing to use the sequential weed mat covering approach known as “Turn-the-Page” (TTP) method developed by Dr. Joe DeFrank from the College of Tropical Agriculture and Human Resources (DeFrank, 2014). The TTP concept is killing existing weeds or cover crops with or without initial weed-whacking in a portion of the field by covering the weeds with a light exclusion tarp (woven weed mat) for 1 to 6 weeks depending on weed densities and types (Fig. 1). The weed mat is then turned over to the adjacent weedy areas. Cash crops are then seeded or transplanted into the dead weed covered ground without having to till the entire planting bed (Fig. 2A). As the weed mat is turned over to the adjacent planting bed, TTP offers a sequential weed management tactic without herbicide, tillage and avoids covering the entire greenhouse with an expensive woven weed mat. Preliminary studies demonstrated that a weedy area dominated by grasses or broadleaf weeds (without nutsedge, Fig. 2B) can be managed by TTP if the field is covered with weed mat for 3 weeks (Domen et al., 2016). Farmers can sequentially cover part of the greenhouse at biweekly intervals, and plant their crop sequentially.



Fig. 1. A) Weedy field plot covered with light exclusion woven weed mat secured with a fire hose filled with water. This weed mat was “turned over” from the field plot at the back. Water hose is used to secure the weed mat instead of using pins to avoid tearing of the weed mat. B) After covering for a sufficient amount of time, weeds under the weed mat will die from light exclusion and the area is ready for transplanting or direct seeding of cash crops.



Fig. 2 A) Corn seedlings were transplanted into “Turn-the-page” (TTP) treated plot. B) Nutsedges are harder to kill by TTP method.

The objective of this project was to examine TTP method inside a hoop house compared to glyphosate-herbicide treatment for weed management. Specific objects were to determine if 3 weeks or 6 weeks of weed flushing prior to TTP could suppress weeds comparable to a glyphosate application.

Materials and Methods

A field was tilled and plowed prior to building four hoop houses of 14'× 20'× 6' with insect exclusion nets as described by Wang et al. (2017) on Oct 19, 2016. Drip irrigation was installed and head cabbage (*Brassica oleracea*) seedlings were transplanted in two planting rows of 20' long with 4' row spacing on Nov 4, 2016. These cabbage seedlings were to serve as rotation crop while flushing the weeds out from the planting rows for 3 or 6 weeks prior to weed treatments: 1) glyphosate treatment at 1.5%, and 2) TTP coverage (as described in Fig. 3). After weed flushing, planting beds were covered with black woven weed mat for 2 weeks using a fire hose to secure the weed mat. Weed mats were then removed and each plot (2'×10') was planted with 3 zucchini seeds (*Cucurbita pepo*) by direct seeding. Each treatment was replicated four times in the four hoop houses. Weed coverage was monitored weekly using Horsfall-Barratt scale on a scale of 1-12 where 1=0%, 2=1-2%, 3 = 3-6%, 4=7-12%, 5=13-25%, 6=26-50% weeds covered; whereas 7=26-50%, 8=13-25%, 9=7-12%, 10=3-6%, 11=1-2%, and 12 = 0% no weeds covered. Thus, weed data for the 3-week flushing was started on Nov 25, 2016 but that for 6-week flushing was started on Jan 11, 2017.



Fig. 3. Procedures to install “Turn-the-Page” (TTP) in the screenhouse.

		
Attach cap to the end to keep water in the fire hose.	Weigh down the weed mat with the filled fire hose.	Turn valve to close water and unhook garden hose from attachment.
		
Cover with weed mat for 2 weeks, spray herbicide on the other half of the planting bed as a control. The right hand side is 6 weeks of weed flushing.	Effective weed suppression by TTP was revealed with the removal of weed mat that was comparable to herbicide treatment at the rear.	Uncovering of the 6-week weed flushing plot revealed weed kill in the middle of the row but some weeds survived on the borders.

Fig. 3. Procedures to install “Turn-the-Page” (TTP) in the screenhouse (continued).

Results and Discussion

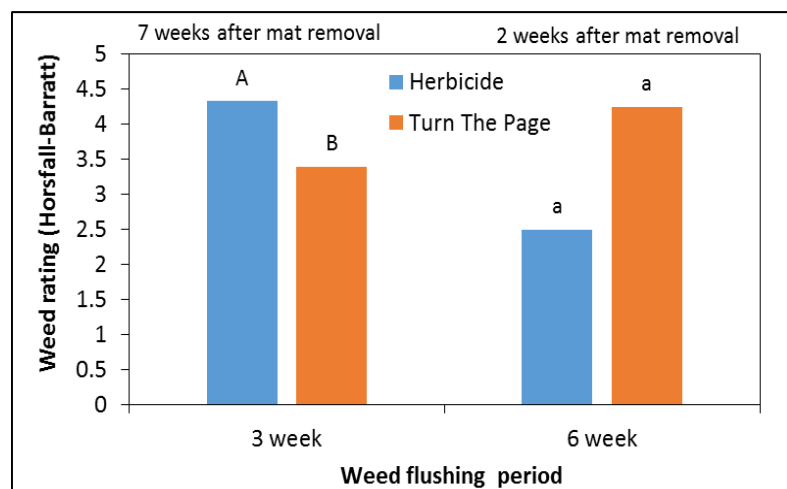


Fig. 4. Weed coverage in herbicide and “Turn-the-page” treated plots after 3 or 6 weeks of weed flushing at 7 and 2 weeks after weed removal, respectively. Weed coverage is based on Horsfall-Barratt scale of 1-12 where 1 = no weeds, and 12 = 100% weed covered. Columns followed by different letters for each flushing period are significantly different based on Waller-Duncan (k-ratio) t-test.

Data collection is still on going. Results collected so far suggested that flushing weeds for 3 weeks provides better weed control in TTP than the glyphosate treatment ($P < 0.05$, Fig. 4). However, flushing weeds for 6 weeks resulted in an abundance of weed biomass too great for TTP to manage. However, flushing weeds for 6 weeks followed by herbicide treatment is an effective (Fig. 4) stale seedbed technique (Hooks et al., 2013) though no significant difference was observed between TTP and herbicide. Further data collection is needed to conclude the study.

Although TTP will not eliminate weeds throughout the zucchini crop, it allows for more manageable hand weeding in an organic farming system. TTP also offers an alternative no-till farming method for small-scale and low-input farming system. Most farmers in Hawaii are reluctant to conduct no-till farming practices due to expensive no-till equipment. Practicing no-till using a weed whacker and weed mat would be an eye opening approach for small-scale farmers. Farmers in Hawaii should pay more attention to soil conservation, as topsoil is the most fertile soil in a farmland. It has been documented that soil runoff from no-till is 6.6 times lower than deep tillage (Wuest et al., 2004). TTP weed management is especially compatible with transplanting, as the crops are more tolerant to weed pressure in this system.

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