FATE OF WEED SEEDS DURING THE MUSHROOM PRODUCTION CYCLE

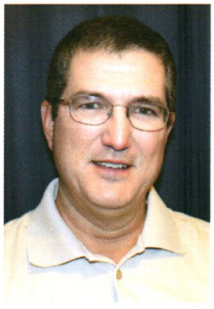
Introduction by

Tom Brosius – Marlboro Mushrooms | **Joe Poppiti** – JoBeth Farms

KURT VOLLMER, Ph.D.

Postdoctoral Researcher
University of Delaware
Carvel Research &
Education Center
Georgetown, DE

kvollmer@udel.edu



MARK VAN GESSEL Ph.D.

Professor
University of Delaware
Carvel Research &
Education Center
Georgetown, DE

mjv@udel.edu

There is a new weed threat to Pennsylvania agriculture and surrounding areas, an invasive pigweed called Palmer amaranth (Amaranthus palmeri). Palmer amaranth is a summer annual, broadleaf weed that is native to the southwestern U.S. and Mexico and unfortunately is spreading eastward. There is a growing resistance of this weed to glyphosate (Roundup) and Group Two herbicides (ALS inhibitors) as a chemical control.

It has been theorized that Palmer amaranth can be spread in equipment, feed grain, hay, manure or compost, including spent mushroom compost. Experienced mushroom farmers believe that all weed seeds are destroyed through the mushroom substrate composting (Phase I and Phase II) and mushroom growing process. Members of the Mushroom Farmers of Pennsylvania (MFPA) Committee who have developed pathways for the beneficial usage of spent mushroom compost (SMC) did not want SMC unfairly characterized as a weed seed vector.

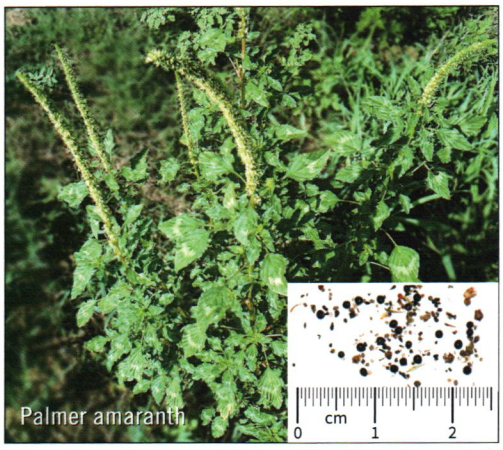
The American Mushroom Institute (AMI) and MFPA, in support of its membership, wanted to scientifically prove if weed seeds are viable after being subjected to the mushroom growing best practices. AMI and MFPA, with the assistance of Mark VanGessel, Ph.D., professor and extension specialist, and Kurt Vollmer, Ph.D., postdoctoral researcher at the University of Delaware, have been investigating whether Palmer amaranth weed seeds could survive and be viable after the mushroom growing process. Several trials were initially performed to determine the best protocol for testing weed seed viability including several types of weed seeds (annual ryegrass, Ivyleaf morningglory, hairy vetch, velvetleaf and Palmer amaranth) and types of exposures to the mushroom growing process. After the protocols were set, a larger trial was conducted. Results are shown in the following report "Fate of Weed Seeds During the Mushroom Production Cycle" in which weed seeds were exposed during Phase II substrate preparation through post crop steam pasteurization.

An additional trial will be conducted in 2018. Weed seeds will be exposed to the mushroom growing process beginning in Phase I mushroom substrate preparation through post crop steam pasteurization.

Thanks to Marlboro Mushrooms, Laurel Valley Farms, Kaolin Farms and Magnolia Farms for allowing trials to take place at their mushroom growing operation and their in-kind assistance.

FATE OF WEED SEEDS DURING THE MUSHROOM PRODUCTION CYCLE

Mushroom substrate often includes hay, corn stover and wheat straw. This plant material may come from fields with weeds present, and in turn, mushroom substrate ingredients may contain weed seeds. Therefore, the use of spent mushroom compost has the potential to transport weed seeds to new areas. However, no research has examined this potential.

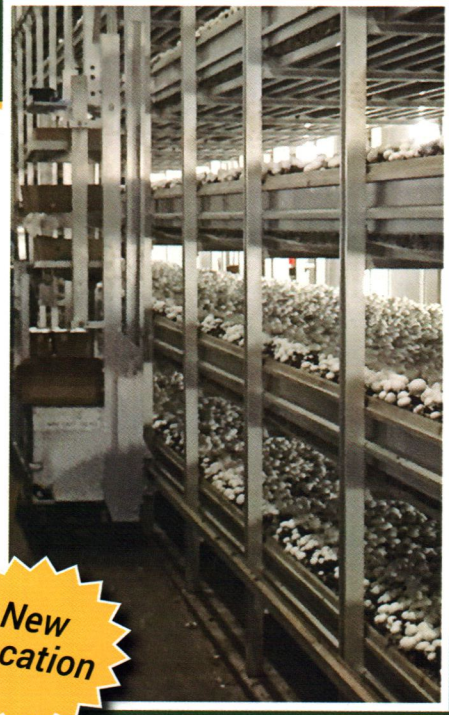


Traditional composting has been shown to reduce weed seed germination; however, high temperatures are needed over a long period of time to completely kill weed seeds. Tompkins *et al.* (1998) found some species lost viability after two weeks of composting; however, others required at least four weeks of composting. Furthermore, Grundy *et al.* (1998) reported that weed seeds could survive in localized "cool spots" in a compost pile caused by inefficient windrow turning. For example, National Organic Standards require compost piles with feedstock material to be managed to ensure a minimum of 55°C for at least three days (USDA 2011).

However, the process used in making mushroom substrate is unique in that the substrate materials are exposed to several additional phases of high heat and humidity; the process is not analogous to standard composting of organic material. We hypothesized that this process will have a negative impact on weed seed viability; allowing for the use of the spent mushroom compost without the unwanted spread of weed seeds. The objective of this study was to examine weed seed viability following four stages of the mushroom growing process, and determine if various weed species respond differently.

KEY FINDINGS

- No viable seed from annual ryegrass, hairy vetch, Palmer amaranth or velvetleaf remained after the post crop steam pasteurization phase of the mushroom growing process.
- Ivyleaf morningglory was the only species to have viable seed following the post crop steam pasteurization phase.

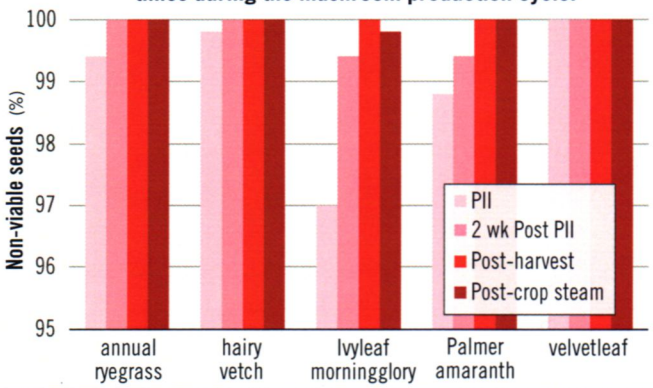


METHODOLOGY

This study was a two-factor factorial experimental design investigating weed species and removal timing from different phases of the mushroom growing process. This study was repeated twice. Weed species consisted of annual ryegrass, Ivyleaf morningglory, hairy vetch, Palmer amaranth and velvetleaf. Samples were inserted at the beginning of Phase II. The removal of the mesh bags timing was (1) at end of the Phase II substrate preparation, (2) two weeks after Phase II substrate preparation, (3) after the final mushroom harvest and (4) following the substrate post crop steam pasteurization. Fifty weed seeds of each species were placed in individual mesh bags, with five replications. Individual species seed bags were placed in onion bags and placed in the mushroom growing substrate prior to the Phase II pasteurization process.

At each sample's timing, onion bags were removed from each mushroom growing house for weed seed evaluation. Weed seeds were pressure tested using forceps, with those unable to withstand slight pressure (mushy) considered dead. Those weed seeds that resisted slight pressure were placed on petri dishes and allowed to germinate over a four-week period in the greenhouse. In addition, weed seeds that were not placed in the mushroom growing house were included in the germination test and served as our control. Weed seeds that remained intact after the germination test were dried and a crush test was performed on each individual weed seed (Sawma and Mohler 2002). Remaining weed seeds were given an additional two-week germination period. If seeds germinated or were intact after the final germination run, they were considered viable.

Figure 1. **Percent of non-viable seeds following four sampling times during the mushroom production cycle.**



[a] Data includes seeds that germinated and seeds that survived the crush test.

[b] Scale starts at 95% nonviable seeds.

[c] Abbreviations: PII, after Phase II substrate preparation; 2 wk Post PII, two weeks after Phase II; Post harvest, after final mushroom harvest; Post-crop steam, following the Post-crop steam pasteurization.

RESULTS & DISCUSSION

The weed species included in this trial did not respond the same to the mushroom composting process. All species, except velvetleaf, had viable seeds at the end of Phase II substrate preparation (Figure 1). Palmer amaranth seeds were also viable two weeks after Phase II substrate preparation, but there were no viable seeds at the last two sampling periods. Viable Ivyleaf morningglory seed was also detected two weeks after Phase II substrate preparation and following post-crop steam, albeit 99.8% were determined to be dead. This trial did not include Phase I composting and ongoing trials are looking at this additional step to see if it will destroy all of the Ivyleaf morningglory. ***mn***

REFERENCES

Grundy, A.C., Green, J.M., Lennartsson, M. (1998). The effect of temperature on the viability of weed seeds in compost. *Compost Science & Utilization* 6:26-33.

Sawma, J.T., Mohler, C.L. (2002). Evaluating seed viability by an unimbibed seed crush test in comparison with the tetrazolium test. *Weed Technology* 16:781-786.

Tompkins, D.K., Chaw, D., Abiola, A.T. (1998). Effect of windrow composting on weed seed germination and viability. *Compost Science & Utilization* 6:30-34.

[USDA] U.S. Department of Agriculture (2011). Guidance: compost and vermicompost in organic crop production. https://www.ams.usda.gov/sites/default/files/media/5021.pdf. Accessed January 22, 2017.