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## Use of an Alternative Natural Weed Suppressant: Effects of Parboiled Rice Hull Mulch on the Growth of Container Weeds

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### Cover Page Footnote

The author thanks Dr. Vanessa Slinger-Friedman of the Kennesaw State University Geography Department and Henning von Schmeling at The Chattahoochee Nature Center for advisement support during the experimentation and documentation process of this journal.

# **Use of An Alternative Natural Weed Suppressant: Effects of Parboiled Rice Hull Mulch on the Growth of Container Weeds**

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## **ABSTRACT**

The Chattahoochee Nature Center (CNC) is one of the leading educational centers in Georgia about the ecology of the Chattahoochee River. Due to lack of man power, keeping down the weeds in the CNC plant nursery is one of those tasks that often gets left undone. The nursery becomes overgrown with invasive weed species. Understandably, they must sometimes resort to the use of herbicides, such as Roundup®, to keep the hundreds of native and endangered species of plants housed at CNC from being choked out by invasive weeds. This study tests the ability to suppress weed growth by use of Parboiled Rice Hulls (PBH), a biodegradable by-product of the rice industry used as an eco-friendly mulch or soil additive. As a result of this study the CNC has planned to implement the use of PBH as a mulch material to dramatically decrease use of herbicides.

**Keywords:** Parboiled Rice Hulls, weeds, Roundup®, pesticide, weed prevention, pesticide alternatives

### **Introduction and Background**

The Chattahoochee Nature Center (CNC) is nestled on 127 acres along the banks of the Chattahoochee River in Roswell, Georgia. In support of its mission, “to connect people with nature” (Mission), CNC prides itself on being one of the leading educational centers in Georgia about the ecology of the Chattahoochee River. Catering mostly to the younger generations, it showcases native plant gardens, butterfly habitats, and injured wildlife that cannot be rehabilitated and released back to the wild. CNC is run by a small staff of approximately 30 dedicated employees and relies heavily on volunteers to help with the grounds keeping. Many tedious tasks are often left undone because of the lack of man power. Tending to weeds in the plant nursery is a task that often gets neglected to the point that the nursery becomes overgrown with invasive weed species. Finding labor alternative, eco-friendly, methods of weed suppression would not only help CNC

economically, but would also improve the center’s impact on the environment.

The CNC plant nursery houses hundreds of native and endangered plant species of Georgia. When the nursery does manage to get weeded, it is often over grown once again within a few weeks. The CNC simply does not have the staff to stay on top of the problem and often must resort to herbicides to control the weeds. When resorting to the use of herbicide CNC elects to use the popular product Roundup®. The exposure of wildlife and humans to residues of Roundup® through agricultural practices or the food chain has been reported since the herbicide was found contaminating rivers. In vivo studies employing snails, fish, and amphibians, and in vitro studies with human and animal cells have been conducted to evaluate the toxicity of this herbicide. In vitro studies showed human cell damage, such as cell disruption and damage to mitochondrial membranes, promoting necrosis and causing total cell death by glyphosate and its commercial formulations, indicating that the

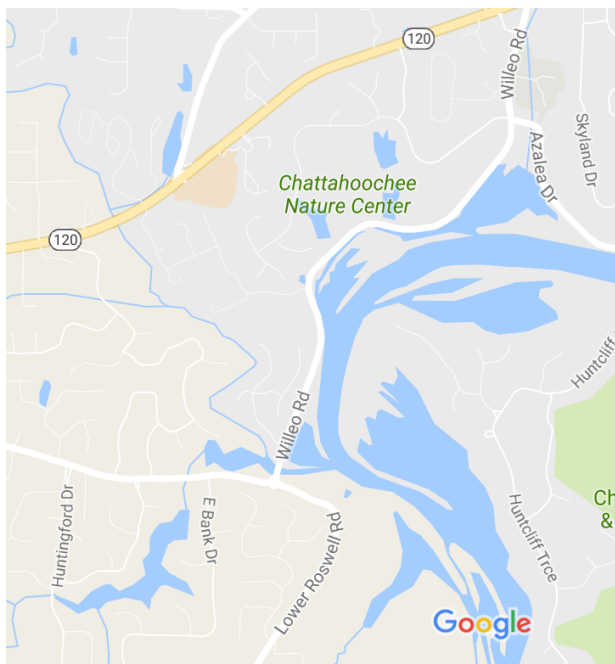


Figure 1. Location of CNC in Roswell, Ga. In the wetlands of the Chattahoochee River

surfactant tallowamine polyethoxylate (POEA) in Roundup® formulations is not inert (Monte et al. 2016). Herbicides eventually wash away from the container soil and end up in the watershed leading to environmental damage. A more environmentally friendly solution is needed for use in the outdoor nursery that will not only control the weeds but also not hurt the environment. This study will discover if the use of parboiled rice hulls (PBH) could be an effective alternative to using harmful chemicals in the nursery and reduce the need for hand-weeding individual containers in the nursery. PBH is a biodegradable by-product of the rice growing industry and has been advertised as being an economical and earth-friendly weed management mulching material. By conducting trials of the use of this media as a mulch for container plants we will determine if it is effective enough in inhibiting the growth of weeds to discontinue the use of herbicides and the practice of hand weeding of container specimens.

## Literature Review

A 2015 study by Moore et al. (282) showed the negative impact Roundup® products have on the environment. Research done on wood frog tadpoles exposed to a sub-lethal concentration of Roundup found, "...the possibility that glyphosate, in sub-lethal concentrations, could inhibit anti-predator responses in larval amphibians due to alteration of olfactory function" (Moore et al. 2015, 282). This alarming study shows that not only does this chemical poison the soil and water, but also threatens species diversity and entire ecosystem food chains.

Although extensive research on the use of alternative mulch methods is limited; a PBH supplier from Arkansas, Riceland Foods, "recommends depth of 1 ½ to 2 inches for effective weed control. Not only is that recommendation impractical in all but the largest nursery containers, it is excessive considering that we found ½ inch to be an effective depth" (Altland, n.d.). Other than this study, little research has documented the effectiveness of rice hulls for controlling weeds in the container environment. (Altland and Krause et al. 2014, 60). Altland and Krause looked at possible effects upon a desired potted plant and several different varieties of weed were subjected to study. Altland and Krause also employed the use of a commercial fertilizer, however, no such implements to enhance plant growth are applied to the subjects of this study. In this study, we aspire to find the effects of PBH at depths of 0.5 in., 1.0 in., and 1.5 in. of mulch medium planted with seeds underneath and on top of the mulch medium. This study differs from those performed by Altland and Krause in that it looks at weed growth without an additional plant in the study containers and substitutes grass seed to measure weed growth. Additionally, whereas Altland's experiment tested only for liverwort and bittercress seed development from *on top* of the PBH mulch, this study looked at effectiveness of PBH mulch on seeds that may be dormant underneath the mulch

and for those that may be windblown and land on top of the mulch.

In Altland's solo experiment, upon which this experiment is based, he explains how weed seeds,

...are small, and must germinate on or near the container substrate surface. When you cover the substrate surface with mulch, small weed seeds don't have enough stored energy to grow through the mulch and establish themselves on the surface. This is primarily how mulches provide weed control, at least temporarily. The problem is that most mulches don't provide long-term weed control because the mulch itself becomes an excellent substrate for weed germination. (Altland, n.d.)

Altland's recommendations for the ideal mulch material should, "provide little or no available nutrients, they dry quickly after irrigation, and they resist decomposition" (2014, 1). All of these requirements are characteristics of PBH mulch. Altland concludes containers with PBH depths of .5 in. and 1.0 in. showed no signs of weed growth, but at a depth of .25 in., "both bittercress and liverwort grew, albeit a lot less than the un-mulched controls" (2014, 2).

A second variable this study examines is how seed growth is affected if planted *under* the PBH. Marble notes, "Many weed species, specifically annual species with small seeds, require light to germinate and germinate at the soil surface or at very shallow depths" (2015, 343). It is also stated that, "Annual weeds in particular have the ability to grow under a wide range of environmental conditions. As a result of their small size and limited reserves, successful germination of annual weed species occurs at the soil surface or at a shallow depth (Samtani et al. 2007, 289). Therefore, it stands to reason that PBH could provide a barrier from sunlight and seeds planted under various depths may not germinate.

## Research Objectives

This observational experiment looks to find viable alternatives to environmentally harmful herbicides and labor-intensive weed control practices for use at the Chattahoochee Nature Center. Potential problems with the use of PBH, as seen with Altland's experiment, will also be assessed in terms of problems with fly-away PBH from windy outdoor conditions. Other problems discovered from these experiments will be reported. We are also looking to evaluate cost effectiveness of the use of PBH, and we predict that it will be effective in saving time, money, and the environment, in that no hand weeding or use of herbicide products will be necessary once a minimum effective depth is found.

## Study Area

The experiment to find the effects of PBH on weed growth development was conducted in Roswell, Georgia in the CNC outdoor native plant nursery to realistically see how this material would hold up in the outdoor environment as it would be used by the container nursery. If found to be successful in deterring weed growth in container plant specimens; CNC plans to implement application of PBH to its existing nursery stock immediately to get ahead of next year's weed infestation.

## Data Sources / Methodology

Weeds become a problem in a nursery setting as well as in nature in two different ways: weed seeds already in the soil that have stayed dormant over the winter will germinate in spring, while seeds that are spread by natural causes, such as wind or water, will settle on top of container soil and germinate later in the growing season. Both are problematic in that weed seeds tend to be very small and are hard to identify until after the weed has germinated and establishes itself. Both scenarios were tested as they both are a problem in the outdoor nursery because of windblown seed dispersal from

established weed species. As mentioned earlier in this article, weed control at CNC is a challenge because of limited man power and often results in the use of environmentally threatening herbicides.

To test different scenarios possible for weed growth in the nursery 42 one-gallon pots were used. The pots were located outdoors in a 6x6ft frame to track any fly-away debris from the PBH and assess if this is a problematic variable that will need to be addressed in the future. The experiment pots were purposely placed near a sprinkler head to ensure appropriate daily watering throughout the trial.

Each pot was filled with a commercial potting soil. Six pots used as controls contained only Fescue seeds and no mulch was applied to the top. Eighteen pots tested for seed germination and growth from seeds planted *under* the PBH mulch; six-½” mulch layer, six-1” mulch layer, six-1 ½” mulch layer. An additional eighteen pots tested for seed germination and growth by setting seed *on top* of the different depths of mulch. These different depths are used to determine cost efficiency and to find at what minimum mulch depth desired results can be achieved. Each pot was planted with 1 teaspoon of Fescue Seed, watered once daily in the morning, and monitored once a week for developments. The start date for this experiment was October 7, 2016 and final results

were observed on November 4, 2016. These trials were based on Altland’s previously documented trials for Riceland Incorporated. A combination usage of primary and secondary data has been used to analyze factors contributing to development of our hypothesis. Partially recreating Altland’s experiment and adjusting it to meet our own needs and purposes at CNC will help us to assess if this mulch medium is viable for use in the natural conditions specific to the CNC outdoor nursery.

### Analysis and Results

Initially, trials were conducted using seed from False Stinging Nettle (*Boehmeria cylindrical*), the most invasive weed found in at least 80% of the container plants throughout the warm season at CNC. However, those seeds proved to not be viable in September and did not germinate in the control containers. Therefore, because of time of year, these trials are conducted using Fescue (*Festuca arundinacea*), a fall germinating grass that should be comparable in determining the effectiveness of PBH on weed growth in containers during the cooler temperatures.



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*Figure 2: Before & after photos show an example of how invasive False Stinging Nettle is at the CNC nursery. This is after six hours of weeding by hand; a very time consuming and labor intensive job.*

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Week one 10/14/2016: Results were calculated by counting the number of grass sprouts and easily put into graph format. All control pots displayed more than 20 sprouts (not shown in graph), and pots with seeds planted *under* the PBH can be seen in Figure 3. Germination data from week one already showed dramatic results in that all pots with seeds on top of the PBH had no signs of germination. It is unknown why 1.0" depth allowed for more seed germination than at other mulch depths tested. However, the 1.5" depth shows significantly less germination from *underneath* PBH mulch than at lesser depths tested. After week one, sprout germination became too numerous to count and therefore data results could most easily be recorded by photographic evidence.

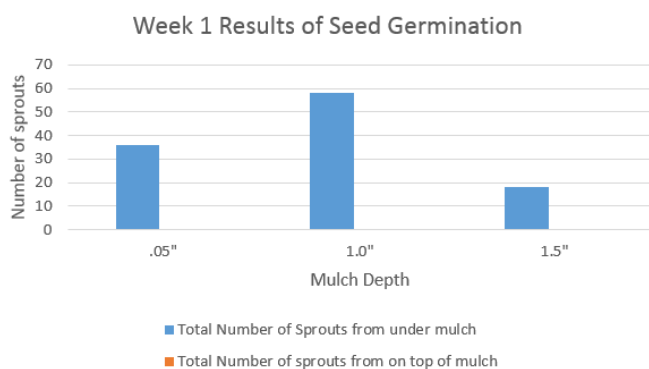


Figure 3: Preliminary results show PBH to be effective in weed inhibition for seeds on top of PBH mulch

Week two 10/21/2016: Containers continued to show the same trend; however, grass sprouts were much more numerous at this point and there was still no evidence of seed germination on top of PBH.

Week three 10/28/2016: Some new developments were a result of unexpected environmental factors. Disturbance of the PBH mulch in four of the pots by wildlife, possibly squirrels or birds, potentially allowed for seed contact with the soil from on top of the mulch. Two pots were affected from the group of seeds



Figure 4: Week 3 Wildlife disturbance caused unforeseen seed contact with the soil.

planted *under* PBH and another two from the group *on top* of the PBH. This may or may not be a variable of concern in that the presence of a desired plant specimen may deter woodland creatures from disturbing it.



Figure 5: Week 3 additional evidence of seed/soil contact in containers



Figure 6: Start of project 10/07/2016



Figure 7: Week 2 results 10/21/2016

Additionally, 5 pots with seed *on top* of PBH contained 1 to 3 blades of grass, mostly around the edges of the mulch in the containers at all depths of mulch.

Week four 11/04/2016: Results continued to be consistent: control containers and containers with seed placed under the PBH mulch were filled with Fescue grass while containers with seed placed on top of mulch show minimum growth. Six containers with minimal growth from *on top* of the mulch have approximately 5-10 blades each, and containers

where mulch was disturbed by wildlife now show growth in those specific areas as well.

These above results suggest that PBH could be a beneficial tool as a weed-deterring mulch medium at CNC. It would be an effective alternative to environmentally harmful herbicide and minimize the need for hand weeding. Although PBH did not inhibit growth from seeds in the soil medium underneath the mulch, it was very successful at keeping the seeds *on top* of the PBH from germinating and confirms Altland's results (Altland, n.d.). A minimum depth of 0.5 inches of PBH mulch would be sufficient, if not



Figure 8: Week 3 results 10/28/2016

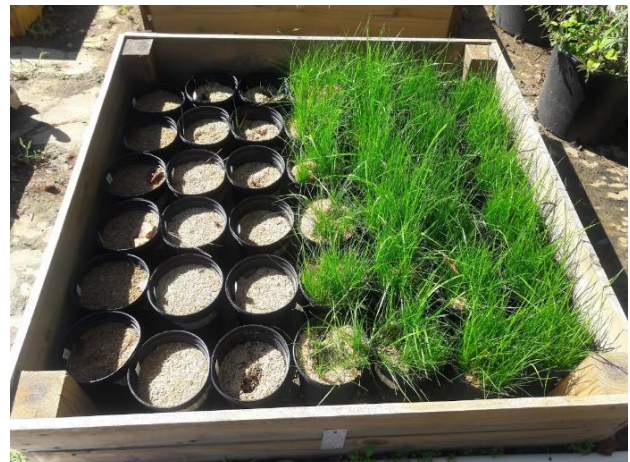


Figure 9: Week 4 results 11/04/2016



disturbed, to inhibit weed growth of transported seeds from on top of the mulch. In instances where PBH mulch coverage becomes disturbed, such as when wildlife disrupts the mulch layer, seeds will germinate. Despite disturbances to the mulch layer. There were few instances of germinated seeds. The minimum amount of weed growth shown by this experiment would be much more manageable than with wood mulch or no mulch at all. This analysis recommends PBH be applied immediately to all container plants housed at the Chattahoochee Nature Center. If PBH is applied, weed seed already in the container soil will not be deterred and those weeds that germinate early in next year's season will need to be removed manually. However, since PBH has shown significant effects on weed germination for seeds that land on top of mulch material, future weed infestations will be much easier to manage.

### **Conclusion and Recommendations for Future Research**

The experiment's early results indicate that PBH is only effective for inhibition of seeds that settle on top of the medium. Although Marble is quoted previously to say, "small seeds require light to germinate and germinate at the soil surface or at very shallow depths..." (2015, 343), it would not be reasonable to believe from the results of this experiment that PBH would stop seeds already in contact with the soil from germination. The seeds placed under the varied depths of PBH clearly were not inhibited from germination. However, once the primary seeds have germinated and then eliminated, PBH will be greatly effective in minimizing weed growth of a second generation of seeds spread by wind and/or water that would land on top of the PBH mulch. Additionally, it is recommended to repeat this experiment with False Stinging Nettle seed during the summer. Since the grass seed is much larger, and theoretically contains more energy than a much smaller weed seed, it could stand to reason PBH could inhibit germination of the smaller seeds of False Stinging Nettle from underneath the mulch layer.

An unforeseen drawback to the use of PBH was not that it was easily blown away by winds, as Altland (2014, 3) notes in his experiments, but that in the outdoor environment at CNC, wildlife might disturb the mulch layer and expose the soil substrate to seed contact as seen in week four evidence of germination. This compounding variable may have been eliminated by the desired plant specimens in the containers in Altland's experiments or simply by replacing any mulch disturbed by wildlife. No blow away PBH was observed during these trials; although, the 6x6 frame may have shielded the area from wind.

Future studies may analyze relationships of PBH to retained moisture content in the substrate soil. It is possible that the use of PBH could also be useful for water conservation and protection of the desired plant from abiotic stresses. When re-setting the experiment for use with Fescue, it was noted that the soil in the control containers with no PBH were considerably more wet than the soils in containers with PBH. It is possible that the use of PBH could be effective in keeping the soil moist and prohibiting excess water into the substrate. Excess water would only leach out of the containers and be wasted. It is possible that the use of PBH could also be useful for further reducing cost in water use and hand watering of the nursery specimens.

### **Acknowledgements**

The author thanks Dr. Vanessa Slinger-Friedman of the Kennesaw State University Geography and Anthropology Department and Henning von Schmeling of The Chattahoochee Nature Center for advisement and support during the experimentation and documentation process of this article.

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