Pine Straw (Pine Needle) Mulch Acidity: Separating Fact From Fiction Through Analytical Testing

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The debate has waged on for many years regarding the acidity of pine straw (also commonly called pine needles and pine straw mulch) and the effects that potential acidity may have on soil acidity and subsequent plant health when used as a mulch. I've read in numerous places that pine straw is acidic, it will turn your soil acidic, and only plants that like acidic soil can be grown with pine straw as mulch. Based on my extensive past experience, I've publicly disputed that statement by stating that although pine straw in itself is slightly acidic, as it breaks down it becomes less acidic over time and has no real negative effect on soil acidity or plant health. I've done some basic research in the past to support that argument, but have been interested in further research and testing in order to strengthen that claim.

Recently, I began performing analytic testing of the acidity, or pH (defined below), of various ages and forms of pine straw and soil to assist in separating fact from fiction. The results of those tests are summarized below.

If you aren't familiar with the term pH, it is simply a measure of a substance's acidity or alkalinity based on a range (scale) of 0 to 14, with 7.0 being considered neutral, less than 7 being defined as acidic, and greater than 7 being defined as being alkaline.

Sometimes the pH scale can be a little misleading though. For example, we know that rain water is healthy for our gardens and we normally think of it as being "pure" and thus somewhat "neutral." But, rain water actually has a normal pH of between 5.5 and 6.0, which is slightly acidic on the pH scale. Before you decide to swear off the benefits of

rain water though, rest assured it is still a safe and healthy bet for your plants, one reason of which I'll discuss later in this article.

My first test consisted of green needles, pulled fresh from the tree. As in all of the needle and soil tests, the needles were placed in a non-reactive container and mixed with an appropriate volume of distilled water following standard analytical testing guidelines and using a proper and calibrated pH meter (single body electrode using standard buffer solutions). The pH of pure distilled water in the container was 6.4. After adding the needles for 10 minutes of soak time, the pH of the green needles was 6.3. To simulate rain water flushing to determine the pH of the leachate of the needles, the needles were allowed to soak for 24 hours and the resulting pH was 4.5. To further simulate the natural rain and drying cycle, the needles were rinsed and then allowed to dry outside for 7 days. The 24 hour soak test was then repeated and the pH was 5.0. The rinsing, 7 day drying cycle and 24 hour soak test was again repeated, followed by two separate 14 day drying cycles and 24 hour soak tests. The pH results were 5.1, 6.2, and 6.5 respectively. From this round of tests, it is clear that the fresh green needles leachate was initially acidic at 4.5, but following several simulations of rain and drying cycles over a few weeks time, the solution (the terms leachate and solution are used interchangeably here) was at the equivalent of rainwater pH. Over a period of 46 days, the needles were no longer acidic, with the pH being that of distilled water.

The second test consisted of freshly fallen needles, the type that would normally be gathered and used as mulch. After 20 minutes of soak time, the pH of the pine straw (the terms pine needles and pine straw can and are used interchangeably here) was 6.6. As with the green needle testing, this test series consisted of an initial 24 hour soak test which was then followed by a 7 day drying cycle, 24 hour soak test, and then two 14 day drying cycles and 24 hour soak tests. The pH results of this series of tests were 5.1, 4.9, 6.0, and 6.0 respectively. In about three weeks the acidity of freshly fallen pine straw was reduced to that of rain water. After 38 days, the pH was increased to 6.0. Following the pattern of the green needle tests the pH likely would reach that of distilled water within the same time frame.

The third test used a combination of whole and broken needles that were bagged and kept dry and out of sunlight since their collection over a span of approximately six months to one year prior to the test. After 30 minutes of soak time, the pH of the pine straw was 5.8. This test was followed by an initial 24 hour soak test resulting in a pH of 4.7. Since the 24 hour soak test result was within the range expected based on previous tests, a 7 day soak test was introduced at this point to look for evidence that longer rain saturation simulation cycles might raise pH at a rate quicker than shorter rain simulation cycles. With the result after 7 days being 5.3, the leaching rate appears to generally

follow the same rate of the previous tests that utilized shorter soak and longer drying cycles.

For my fourth test, I utilized decomposed pieces of needles that were approximately 3 months to 2 years old. These pieces were taken from the garden and at the bottom of a five to six inch deep pine straw mulch layer. This mulch has been continually added to, with the top layer being placed there as recently as 3 months ago, and the bottom as long as two years ago. The primary intent of this test was to determine if downward leaching impacted lower levels of mulch. After 30 minutes of soak time, the pH of the pine straw was 4.9. This test was followed by an initial 24 hour soak test resulting in a pH of 4.9 and then a 7 day soak test, after which, the pH was raised to 5.6. These results initially suggest that downward leaching may occur, but longer saturation reduced the pH of the leachate quickly and to that of rain water.

My fifth test utilized decomposed pieces of needles that were approximately one year old and obtained from the topmost layer of pine straw in a sunny and very dry area of my garden. After 30 minutes of soak time, the pH of the pine straw was 6.9, which was followed by a 24 hour soak test resulting in a pH of 6.0. Both of these results follow the same previous patterns of reduced leachate acidity over time.

The remaining tests were performed on soil native to my area to determine the long term impact of pine straw leachate on soil pH over time.

My initial soil test was performed on clean soil not exposed to any pine straw or its leachate with a pH result of 6.5.

The second test used soil obtained in the same area, but from under a five to six inch deep pine straw mulch layer that consisted of one year old decomposed pieces of pine needles. The pH result was 7.4. Due to the unexpected results of this test (expectation was that it would be equal to or lower than the first test), the pH meter was recalibrated and the test was repeated on a new soil sample taken from a different location in the same general area. The result of that test was identical to the original test, returning a pH of 7.4.

The third test consisted of soil that is under a ten to twelve inch layer of six month old pine straw mulch located under three 50 year old pine trees that have continually bombarded the soil with slightly acidic pine needles. The initial expectation prior to this third test was the soil would be highly acidic with a pH lower than the results in the first two tests. The actual test revealed a pH of 7.4, the same as the area with five to six inches of one year old decomposed straw. Based on the background sample that was

not exposed to pine straw used in the first soil test, it appears that the soil in the second and third tests had buffered any leachate acidity to near neutral levels.

The main purpose of this particular series of testing and research was to determine if pine straw leachate was acidic and if so, did that leachate in turn create acidic soil conditions that might cause a negative impact to plants. In summary, here is what the testing results reveal:

- Green pine needles are acidic but lose their acidity over a short period of time as they dry out and are exposed to rain and outside weather conditions. Green needles aren't normally used as mulch, but if were to be, further testing would be required to determine longer term soil impacts of using the higher acidity green needles.
- Freshly fallen needles, the type that are normally used as mulch, are slightly acidic when fresh, but within approximately three weeks of falling from the trees, leach a solution that is about the equivalent of rainwater.
- Downward leaching of some acidity may occur when new needles are used over older needles, but the soil buffers it with no negative acidic impact to the soil itself. This could be a partial explanation as to why weed seeds struggle to germinate in pine straw mulch.
- Older straw continues to lose acidity over time when exposed to rain and outside weather conditions.
- Soils can buffer the slight acidity of freshly fallen needles and thus, there is no negative impact to plants from the slight acidity of pine straw when used as mulch.

So why do so many people believe pine straw mulch is only good on plants requiring an acidic soil?" This comes from the common misconception that pine needles are "highly" acidic and thus will turn your soil "highly" acidic and damage non acid-loving plants. We know soil pH is highly critical to plant health. It directly impacts the plant's ability to absorb soil nutrients that it requires to grow, thrive, and fight off diseases, as well as to absorb any herbicides, pesticides or fungicides used to fight diseases or pests that can injure or kill it. This ability is at its maximum when the soil pH is between about 5.8 and 6.5. Based on that, my test findings are significant in that the pH of the freshly fallen pine straw leachate was 6.0 at three weeks time. Most pine straw will be at least three weeks old by the time it is harvested, made available for purchase (or gathered yourself), and used in your garden. So the leachate that would reach your plants' roots and surrounding soil would not only be the equivalent of rainwater, but also in the perfect range for maximum nutrient absorption. Even the initial test results of 4.9 and

5.1 over the first two weeks testing period are insignificant, as the ability of soils and roots to buffer pH are widely known and understood.

So for those who hold up their healthy, vibrant and extensive flower and vegetable producing acid-loving plants as an example of the merits of the acidity of pine straw, I wholeheartedly agree. But for those worried about using it on their not so acid-loving plants, consider these properties that allow it to outperform other mulches and allow your plants to grow and thrive equally as well as their acid loving brethren:

- it provides the perfect level of acidity for your plants to absorb maximum soil nutrients
- it doesn't float and wash away and breaks down more slowly, so it doesn't need to be reapplied as frequently as other mulches
- it is easier to handle and lighter per cubic foot than other mulches: one large bale can cover as much area as 30 cubic feet of most mulches
- the cost per square foot is competitive with other mulches
- it breathes better, doesn't compact, and allows for better water infiltration
- it is easy to apply: just unroll the bales and scatter by hand
- it doesn't attract termites
- it adds organic material and nutrients to soil and reduces weeds
- the uniform color and fine texture of pine straw brings out the color, contrast, and texture of your landscape
- you can use it for erosion control where grass won't grow to hold soil, even on hillsides and paths