How Does Soil pH Impact Herbicides?

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There are many factors that influence the persistence and uptake of herbicides with soil activity. One of those factors is soil pH or the amount of hydrogen ions (H^+) present in the soil solution. Some herbicides will persist for an extended amount of time or rapidly degrade when outside of neutral or near neutral pHs (6.0 to 7.0).

The impact of soil pH is not consistent across herbicides. The triazines (atrazine, simazine, etc.) and sulfonylureas (chlorsulfuron, metsulfuron, etc.) are two herbicide chemical families that are especially affected by soil pH (Table 1). For other herbicide families, pH may play a role in persistence and/or breakdown but may not be the most important factor when considering the herbicide's activity. Whereas, the imidazolines (imazamox, imazapic, imazethapyr, etc.) are moderately influenced by soil pH and the dinitroanilines (pendimethalin, trifluralin, etc.) and the active ingredient clomazone are somewhat influenced by pH. For the dinitroanilines and clomazone, degradation by light and/or volatility is more important than pH when it comes to the activity of these herbicides. There are also several herbicide families that are reported to be affected by soil pH, but little information exists regarding how they are affected. These families include the pyridine carboxylic acids (picloram and clopyralid), uracils (terbacil) and phenylureas (diuron and tebuthiuron).

The two chemical families, the triazines and sulfonylureas, most affected by soil pH persist longer and are more available for plant uptake in higher pH soils (> 7.0), while the opposite is true for imidazolinone herbicides, which persist and are more available for plant uptake in lower pH soils (< 6.0). The persistence of the triazines and sulfonylureas in high pH soils is a result of a decrease in chemical and microbial breakdown, a trend that is often observed in high pH soils where neutral herbicide molecules are loosely adsorbed to the soil and are more available for plant uptake. In low pH soils, triazine and sulfonylurea herbicides become charged and are more tightly adsorbed to the soil where they are more susceptible to breakdown.

A key management factor that must be considered when evaluating a field's soil pH is whether the field is no-till, minimal tillage or conventionally tilled and for how long that system has been used. Tillage will impact how deep soil samples should be taken to determine soil pH. In no-till and minimum tillage fields, the traditional method of 0- to 6-inch soil cores or plough layer may not be adequate. Instead, a 0- to 2-inch core depth and a 2- to 6-inch core depth may be needed, as the application of limestone to the surface may increase surface pH more than expected or the application of nitrogen fertilizer to the surface may cause a drop in pH at the surface. In many long-term no-till fields with historic surface applications of N

Table 1. Herbicide chemical families or selected herbicides that are most affected by soil pH.

Herbicide chemical family or active ingredient	*Common name (trade name) examples*	*Importance of soil pH*	*Soil pH considerations*
Sulfonylureas	Chlorsolfuron + metsulfuron (Finesse C & F), metsulfuron (Ally XP)	Extremely	pH > 7[a] - persist longer and are more available for plant uptake
Triazines	Atrazine (AAtrex), simazine (prince)	Extremely	pH > 7 - persist longer and are more available for plant uptake
Imidazolinones	Imazamox (Beyond), imazapic (Plateau), imazethapyr (Pursuit)	Somewhat	pH < 6 - persist longer and are more available for plant uptake

[a] Highly Acidic Soils < 5.5, Alkaline Soils > 7.5

and no lime applications, significantly low soil pH values (~4) have been observed near the surface (0 to 2 inches) while the subsurface (2 to 6 inches) will be at a typical pH (~6). Since herbicides with a soil residual are affecting plants near the soil surface, the shallower soil layers are of higher interest.

Oklahoma and Kansas production fields can have a wide range of soil pH from field to field and within field. In a dataset of over 300 grid-sampled fields from Oklahoma (259 fields) and Kansas (47 fields), the average field pH was 6.0. However, the average range in the lowest and highest soil pH within the fields was 1.9. This means that the average field had a pH range from 5.0 to 7.0. Furthermore, it should be noted that more than 25 percent of the fields had a pH range of 3.0 units. This range of highs and lows has helped explain the presence of spotty herbicide issues on several fields in the past and should be taken into account when planning crop rotations.

It is extremely important to know and understand the pH of soils; not only for the crops grown, but also for the herbicides you plan to use and how they will react. Soil testing is the only way to know soil pH . Read the herbicide label to learn if soil pH affects the herbicide.

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