Potato Herbicides Spring 2019: Where are they and what are they doing?

Pamela J.S. Hutchinson, Potato Cropping Systems Weed Scientist, University of Idaho Aberdeen R&E Center

You may be wondering what has been happening to your soil-applied potato herbicides during and after the unusual rainfall occurring this spring in Idaho.

- High soil moistures + coarse- medium-textured soils = increased availability and/or downward herbicide movement to or below germinating plants, developing shoots/roots.
- Germinating weed seeds, roots, shoots relative to herbicide location: reduced period of weed control if herbicide below point of uptake by weed **or** increased efficacy increases because herbicide availability is increased and it is in the right location.
- Potato injury if developing roots, developing shoots, sometimes seed piece is at the wrong place = where there is herbicide available for absorption by the roots or shoots **and** the wrong time = slowed potato growth, which slows ability of plant to metabolize the herbicide.

Table 1. Rainfall amounts in April and May 2017 across southern Idaho.

	April	May
	accumulated precipitation (in)	
Ashton	1.3	1.2
Idaho Falls	1.7	5.6
Blackfoot	2.3	2.8
Fort Hall	1.8	1.9
Aberdeen	1.3	1.0
Rupert	1.2	3.2
Kimberly	1.6	2.3
Glens Ferry	2.2	3.4
Boise	2.4	3.5
Parma	1.4	2.9

Okay, so that's a lotta rain! In addition, most of the May rainfall occurred during the last half of the month which was after application of preemergence potato herbicides in many fields.

- With all that rain, is the herbicide's solubility impacting availability and movement in the soil-water solution?
- Does our coarse-textured sandy and loamy sand, and medium-textured sandy loam, loam, and silt loam soils have something to do with availability/movement of soluble herbicides?

The answers are yes and yes.

Another question to ask since location of a herbicide in the soil is important:

- When in the soil, is the herbicide taken up by roots and/or shoots…does it inhibit germination?

Important to remember – *potato safety to potato herbicides is mainly by the speed at which the plant can metabolize the herbicide* to non-herbicidal compounds i.e. anything slowing down potato plant growth, such as cold weather, cloudy conditions, heat/drought stress, and/or stress from diseases/insects/nematodes, also slows down metabolism and possibly resulting in injury. Once growth resumes, then adequate metabolism for safety resumes i.e. *potatoes "grow out" of injury*.

Herbicide movement in soil

Herbicides move in soil depending upon herbicide characteristics such as solubility as well as soil properties including texture, organic material (O.M.) levels, and pH. Irrigation, rainfall, irrigation + rainfall amount and intensity impacts herbicide (and treated soil) movement accordingly.

Herbicide solubility in water is often expressed as the weight of the compound which dissolves in one liter of water (Table 2).

- Stated as mg/L or ppm, whichever you prefer. Water with the same temperature and pH is used for this test so that solubility can be compared fairly.
- *What is most important to know is that the larger the value, the more soluble the herbicide is in water*.
- Depending upon soil characteristics, *the more soluble the herbicide, the more available it is for uptake, and the further it can move down in the soil profile*.

Table 2. Potato herbicide solubility; location of plant uptake below ground; action disrupting plant germination, growth, and emergence; and possible potato injury symptoms. Solubility measured in pH 7 AT 77 F. *The greater the solubility value the more soluble the herbicide* relative to the other herbicides in the table.

Herbicide trade name	**Solubility in water ppm (mg/L @ 77 F pH 7)**	**Location of uptake by broadleaf plant <u>below soil surface</u>**	**Herbicide action <u>in soil</u> to disrupt germination, growth and/or emergence**	**Possible potato injury symptom(s)**
Matrix	7,300	Germinating seedling	Amino acid inhibitor – stops growth	if potato plant emerges - leaf mottling and puckering/wrinkling; growth could slowly stop
metribuzin (multiple trade names)	1,200	Root/some shoot	Photosynthesis inhibitor - Susceptible weeds *emerge and die* immediately after emergence	If potato plant emerges - yellowing in the leaf veins (not between veins). White-skin, short-season varieties are usually more susceptible than russeted
Sulfentrazone	780*	Root	Cell membrane disruptor	If plants emerge, then sometimes blackening
Outlook	1,174	Below-ground shoot and some root; possibly	Stops growth of weed shoots, germinating seedlings	If plants emerge, then a drawstring effect on leaves and/or distorted,
Dual Magnum	488			

		movement w/in weed seedling before emergence		sometimes downward cupping leaves; stem might not recover and new stem/sprout growth below surface; can stop germination
Eptam	370	absorbed as a gas by shoots; can move in germinating seedlings	Inhibits weed seedling germination	If plants emerge, then possibility of leaf distortion/puckering; possible stunting; emergence delayed
Linex	75	Root/some shoot	Photosynthesis inhibitor (*plants emerge and die quickly*)	If plants emerge then yellowing on leaf edges, overall yellowing or between-the-veins yellowing of leaves; possible stunting
Reflex	50	Root	Cell membrane disruptor	Emerged plants splashed by treated soil during intense rainfall could have burnt spots on stems, leaves; if in contact with treated, wet soil – yellowing, burnt leaves
Chateau	2			
Sonalan	1	Mainly root	Stops plant cells from dividing – root inhibitor	
Treflan	<1			
Prowl H2O	<1	Roots only; *possible effect on shoots only in direct contact*	Stops cell division in roots – cells might enlarge but do not divide	Stubby, "club-foot" roots; little or no root hairs; possible brittle stems; If somehow in contact with shoots belowground, then possible thickening

*When tested at pH 7.5, sulfentrazone solubility increases to 160,000 ppm.

Potato herbicide solubility and effects of soil texture on herbicide movement/availability

As per Table 2 (measured in water at pH 7), the solubility of

Matrix, metribuzin, and Outlook > Dual Magnum and Eptam > Linex and Reflex >> Chateau, Sonalan, Treflan, and Prowl.

NOTE: sulfentrazone solubility in water at pH 7 is 780 ppm but when measured at pH 7.5, increases to 160,000 ppm.

In general, movement of these potato herbicides can be greater in our coarse- and medium-textured soils e.g. sand, sandy loam, and loam, than in soils which are finer textured because of the higher silt and clay content. The % O.M. has an effect, too, since it can "tie up" even neutral-charged herbicides.

Effect of herbicide on weeds because of herbicide location in the soil due to solubility and soil texture

Many weeds germinate in the top 2 inch soil layer, sometimes called the weed-seed germination zone. Most soil-applied potato herbicides must also be in that zone to effectively control those weeds. Herbicides can move down below this zone, however, and if that occurs, the period of time for weed control is shortened. More specifically, the herbicide needs to be where it can be absorbed by the weed e.g. if by roots, then where the roots are developing. However, if soil moisture increases herbicide availability and herbicide is "where it needs to be" *then control could be increased from typical*.

What about potato injury from herbicide in the soil? The possibility of injury from herbicides in the soil can increase if the following occurs:

The herbicide is more available than typical due to solubility, especially in coarse- medium-textured soils with low %O.M.

AND/OR

the herbicide is at the point of uptake by the potato plant below the surface,

AND

potato growth is slowed below (or sometimes above) the soil surface resulting in slow metabolism and reduced tolerance by potato.

EXAMPLE of POSSIBLE INJURY by HERBICIDES:

Dual Magnum or Outlook: slow or no emergence, emerged plants have wrinkled leaves, drawstring effect on leaves make them appear heart-shaped. Plants emerge/grow out of leaf injury once conditions "warm up" and sunshine prevails plus potato plants are not stressed by some other factor(s).

Rainfall has been unusually high after herbicide application to the soil

- These soluble herbicides (Outlook more than Dual Magnum) are very available for uptake by the plant shoots developing below the soil surface.
    - maybe the soluble herbicide has moved far enough down in the soils to be where the roots are developing and taking up the herbicide.

It has been cold, even cloudy, and potato plant growth is slowed enough to where it can't metabolize the herbicide fast enough to be safe.

- Emergence is slowed, because these herbicides work by inhibiting the development of amino acids and proteins needed for growth

If/when the plants emerge, and the herbicide is still located where it is being absorbed by the below-ground shoots and maybe now it is located at developing roots,

- Now the leaves can't develop and grow normally because those amino acid and proteins for growth are still not where needed and at the right amount resulting in heart-shaped leaves as if they've been pulled by a drawstring at the leaf base; perhaps leaves are wrinkled and maybe even cupped downward.

Once warm temperatures and sunny conditions prevail,

- Potato plant growth below/above soil surface starts/resumes at regular speed
- The plant can metabolize the herbicide fast enough to non-herbicidal compounds so that
- Amino acids and proteins needed for growth are no longer being prevented.

You do the diagnostics after seeing what is happening or not happening to the potato plant. The same conditions as described above are causing slowed metabolism by the potato plant and increased herbicide availability and/or movement. What injury symptoms are present? Refer to Table 2 to understand where the plant developing below the soil surface absorbs the herbicide – is it the shoots? Roots? *Maybe the herbicide is located where it cannot be absorbed, but somehow affects the plant part by being in direct contact e.g. Prowl H2O.*

Pamela J.S. Hutchinson
Potato Cropping Systems Weed Scientist
University of Idaho Aberdeen R&E Center

You can always text and send pictures to me 208-681-1304; email phutch@uidaho.edu.

May the force of warm and sunny weather be with you!