DEALING WITH ALKALINE SPRAYS

by T. E. "Ted" Whitmore

Alkaline spray mixes can seriously reduce the effectiveness of many pesticides, some in less time than it takes to spray the tank out. Poor results and serious crop losses can be the bottom line. Many pesticide labels carry statements cautioning against combining the product with alkaline materials such as lime sulfur, Bordeaux mix, calcium chloride, etc. This is because their effectiveness will be reduced by alkaline hydrolysis.

Alkaline hydrolysis is an irreversible chemical reaction in which OH− (hydroxyl ions) break pesticide chemical molecules apart, reducing them to other chemicals having no pesticidal qualities. Hydrolysis occurs whenever sensitive pesticides such as organophosphates, carbamates, and synthetic pyrethroids are put into alkaline spray solutions (8).

Do you know the pH of the water where you fill your spray tank? You should. It is the main ingredient in your sprays; the medium into which you will pour many dollars worth of pesticides.

According to Dr. W. K. Hock, Penn State University, "A pH of 7.5 to 8.5 is quite common for many waters in the U.S. The pH of the Great Lakes is in the alkaline range; Lake Michigan ranges between 7.5 and 8.5, while Lake Ontario is 7.9 to 8.3" (6). A lot of city water is in the 9.0 to 9.5 pH range because of water treatment procedures and materials (8).

Mildly to moderately alkaline waters, with a pH of 7.5 to 8.5, are much more common in the U.S. than acid waters. City water frequently ranges upward between 9.0 and 9.5 due to water treatment procedures (6). You must also be aware that water pH can vary greatly between sources, even within a small geographical area. Water from surface streams, ponds, lakes, and rivers varies continually.

But even more important! What is the pH of your spray solution? That is the environment in which your pesticides will live or die before the spray finally dries on your crop. That is where you must have the pH right!

Many pesticides and other spray ingredients will change the pH of spray solutions. Some insecticides and fungicides significantly acidify or alkalinize spray solutions; many plant nutrients are acid while others are alkaline. Some spray materials also possess significant buffering qualities. Each ingredient in the spray may have an effect on the pH of the final spray solution.

Acidifying means to make a spray solution more acidic or to lower the pH. Alkaline materials have the reverse effect, making the solution more basic or raising the pH. Buffers give a resistance to pH changes, either up or down.

Look at the effect of pH on some of our commonly used pesticides. The information in Table 1 is from EPA Fact Sheets and other reliable sources. But the reader should also be aware that similar information from other equally reliable sources may differ due to differing analytical procedures and interpretation of test results obtained.

You may wish such information were readily available for all spray chemicals, thinking it would reduce your guessing and increase the efficiency of your sprays. But such data would only be an average at best and the variations could be significant. This is especially true for the same active pesticides from different manufacturers using different formulating ingredients.

Dealing with the Problem

So how does the spray manager deal with the problem? Get a pH Meter or other testing procedure and use it every time you make any change in your spray mix; every time you: 1) change any ingredient or adjuvant in the solution, 2) change the form of any chemicals—like to dry or liquid, 3) change your source of chemicals—different manufacturers, 4) change sources of water (re-check each surface or shallow well water source frequently since they may change rapidly throughout the spraying season) or 5) whenever anything is different than the last time a check was made.

The best equipment is a good electronic pH

Table 1. Alkaline hydrolysis. Effect of high pH spray solutions on some commonly used pesticides.

Chemical	*Common name*		*Comments*	*Ref.*
Carzol	formetanate	pH 9.0	½ life = 3 hours	(7)
		pH 7.0	= 14 hours	
		pH 5.0	= 4 days	
Counter	terbufos		Subject to hydrolysis under alkaline conditions	(9)
Cygon	dimethoate	pH 6.0	½ life = 12 Hours.	
			Unstable in alkaline water.	(7)
Diazinon	diazinon	pH 8.0	½ life = 8 weeks	(8)
		7.0	½ life = 10 weeks	
		6.0	½ life = 8 weeks	
		5.0	½ life = 2 weeks	
Dimecron	phosphamidon	pH 10.0	½ life = 30 hours	(7)
		7.0	½ life = 13.5 days	
		4.0	½ life = 74 days	
Dursban	chlorpyrifos	pH 8.0	½ life = 1.5 days	(8)
Lorsban		7.0	½ life = 35 days (5 weeks)	
Dylox	trichlorfon		Degrades rapidly (approx. 99% of applied	(9)
Proxol	trichlorfon		degraded in 2 hrs) in alkaline pond water (pH	
Dipterex	trichlorfon		8.5) at room temperature.	
Furadan	carbofuran		Unstable under alkaline conditions.	(9)
Guthion	azinphosmethyl	pH 9.0	½ life = 12 hours	(8)
		7.0	½ life = 10 days	
		5.0	½ life = 17.3 days	
Imidan	phosmet	pH 8.3	½ life = less than 4 hours	(8)
		7.0	½ life = less than 12 hours	
(Notice temperature effect		7.4	½ life = *7.1 hrs @ 68° F.*	
on degradation rate)		7.4	½ life = *1.1 hrs. @ 100° F.*	
		4.5	½ life = 13 days	
Malathion	malathion		Stable at pH 5.0-7.0 but rapid hydrolysis	(4)
			in more acidic or alkaline solutions	
Sevin	carbaryl	pH 9.0	½ life = 1 day	(8)
		8.0	½ life = 2.5 days	
		7.0	½ life = 24 days	
Systox	demeton	pH 6.0	½ life = 18 hrs.	(4)
Captan	captan	pH 8.2	½ life = 10 minutes	(8)
		7.1	½ life = 3 hours	
(Notice degradation rates		5.2	½ life = 10 hours	
above and below pH 5.2)		4.0	½ life = 4 hours	(4)
Difolitan	captafol		Decomposes rapidly above 9.0.	(9)
Dyrene	anilazine		Subject to hydrolysis	(9)
Polyram	polyram		Unstable under strongly acidic or	(4)
			alkaline conditions	

meter that can be calibrated to a standard test solution. A suitable meter will cost from $90.00 up, which may sound like a lot of money but is inexpensive compared to the value of the chemicals and nothing compared to the value of the crop you're protecting. Cheap meters are mostly that and of questionable reliability.

One very good electronic pH meter fits into your shirt pocket and can be used anywhere. It is a miniaturized version of a full-fledged lab instrument but weighs only 4 oz., measures only 1" X 5/8" X 5½", has a pocket clip and operates on 4 readily available hearing-aid batteries. This state of the art meter gives quartz digital readings, has a 2-12 pH operating range and is accurate to 0.1 pH. The "Nester pH Pen" is made by the Nester Instrument Co., who are known for making good pH testing equipment. In the Great Lakes area the 'Nester pH Pen' is available from J. Mollema & Sons, 1530 Eastern Ave. S.E., Grand Rapids, MI 49507 and probably some other sources. A 'pen' costs $88.00 plus $2.00 postage and handling. This is not the only pH meter or source and is mentioned here only as an example of a convenient instrument to help solve the problem being presented.

Litmus and pHydrion papers have long been used for testing spray water pH and are economical. But the pH readings obtained are general at best and interpretation of the colors is often difficult, especially in spray solutions containing pesticides with colors of their own. Don't count on papers for readings closer than 1 to 2 pH units (6).

Several liquid drop systems are also available but are generally less accurate than the papers. Readings depend on color interpretations that are usually quite general in the first place and pesticide color distortions become even greater than with the litmus paper tests.

What pH is Best?

A safe spray solution pH for most pesticide chemicals is probably between 4.5 and 7.0 with the best probably between 5.0 and 6.0. But good data are lacking and some pesticides would not fit into these parameters anyway (8).

There are a few materials with which acidification should not be used. Sprays containing fixed copper fungicides such as Bordeaux, copper oxide, basic copper sulfate, COCS, etc., should not be acidified because the acidity may solubilize sufficient copper to cause plant injury (7).

To be practical, several considerations are important:

1. For a single alkaline ingredient spray like lime sulfur or Bordeaux mixture, the pH doesn't make any difference.
2. How long before the spray will be dried on the crop? If only about an hour, pH 7.0 is usually satisfactory. But many tanks of concentrate spray require several hours of spraying time and a pH of 5.5 to 6.0 may be much better.
3. How touchy are the pesticides in the spray mix? Some will require adjustment even for very short times.
4. If a mechanical breakdown or other problems necessitate a shutdown of spraying operations, the spray solution pH should be adjusted into the 5.0 to 6.0 pH range.
5. Spray solution temperature: (see following paragraph).

Spray Solution Temperature

Most chemical reactions take place faster in warm solutions than in cold ones. This can be important in warm climates or in warm water. It can also be important in high concentrate spraying operations when several hours may be required to spray out a single tank. The friction of constant recycle pumping can raise the tank solution to surprisingly high temperatures before the last of the solution is sprayed. Temperatures as high as 150° F. have been known to occur. Sixty-eight degrees F. (20°C.) is a good median spray solution temperature.

How to Correct Spray Solution pH

A number of acidifying and buffering adjuvants are readily available and are used by adding them into spray solutions. A few general procedures may be helpful:

1. Mix your first tank of spray—omitting any spreader-stickers (They can mess up your pH meter or test.)
2. Check the pH of the spray solution and adjust with acidifying adjuvant. Use 4 fl. oz. per

addition and recheck the pH after each addition, until the desired pH is achieved. Remember how much acidifier was needed.

3. Check the spread of some spray drops on the crop to be sprayed to see if additional spreading agent is needed. Add spreader-stickers or extender-sticker-spreaders last before you spray.
4. In filling subsequent tanks of the same spray mix, *add the acidifying agent first*, before any other chemicals! This will correct the pH before your chemicals are damaged and will normally help and speed mixing.

Acidifying agents. A number of acidifying and buffering adjuvants are available through good Ag Chemical suppliers. Some of them also function as spreading agents or have other benefits. SPRAY-AIDE (Miller Chemical & Fertilizer Corp.), for example, is a triple purpose adjuvant, functioning not only as an acidifying agent but as a surfactant (spreader) and compatibility agent as well. These extra benefits can often take the place of other costly spray adjuvants. A WORD OF CAUTION! Cleaning compounds, often sold and used as spray adjuvants, usually contain alkaline 'builder' components which increase and aggravate spray solution pH problems. The purpose of the alkaline 'builders' in cleaners is to help lift foreign matter from surfaces being cleaned so it can easily be washed away. Pesticides are foreign matter on plant surfaces and pesticide washoff problems will increase when cleaning products are used as spray adjuvants.

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