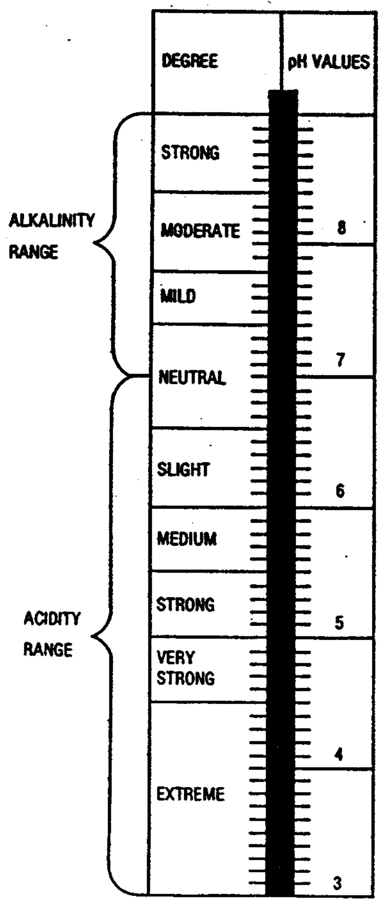
The pH Factor

A basic understanding of pH in water and soil.

THE pH FACTOR - By Paul Sartoretto, Ph.D., *technical director, W.A. Cleary Chemical Corporation*

pH In Water

Almost everyone knows that water with a pH reading of 7 is neutral, neither alkaline nor acid. Perhaps, not as well known is the fact that pH numerical readings are expressed on a logarithmic scale. In other words, a pH of 8 is ten times more alkaline than a pH of 7, and a pH of 9 is one-hundred times more alkaline than a pH of 7. Likewise, a pH of 6 is ten times more acid than 7, and a pH of 5 is one-hundred times more acid, and a pH of 4 is one thousand times more acid than a pH of 7.



Here are several common substances to help explain the pH scale:

↑ Alkalinity Increases	Soap Solution	pH 9.3	
	Sea Water	pH 7.9	Alkaline
	Human Blood	pH 7.3	
	Pure Water	pH 7.0	Neutral
↓ Acidity Increases	Fresh Milk	pH 6.7	
	Sour Milk	pH 4.7	
	Orange Juice	pH 3.7	Acid
	Lemon Juice	pH 2.4	

The pH of water that is available is something over which you have no control. You can be blessed with a source that runs 6.5 to 7, or can be cursed with water that runs as high as 8, 9, or even 10. Constant irrigation with highly alkaline waters is a serious problem which can only be corrected safely by repeated applications of elemental sulfur which slowly and safely oxidizes to sulfur dioxide and sulfur trioxide neutralizing the alkalinity.

However, this discourse is confined to the effect of pH of water on various pesticides in the spray tank and the measures one can take to partially compensate for some of the deleterious effects of alkaline waters.

In general the loss in effectiveness is due to hydrolysis; and the rate of hydrolysis is determined by (1) pH, (2) the chemistry of the pesticide, (3) time of exposure in the spray tank, (4) temperature of the water in the spray tank.

(1) As stated before, pH is measured in logarithmic units and the hydrolysis rate of an alkaline sensitive chemical will increase by a factor of ten for every pH unit.

(2) The chemistry of the pesticide is an extremely important factor. Most chemicals will undergo alkaline hydrolysis. On the other hand, some are acid sensitive and will undergo acid hydrolysis.

(3) Time of exposure in an alkaline medium is also a critical factor. What comes out of the spray tank during the first hour of spraying could be more effective than what comes out during the last hour of spraying.

1/91

(4) An increase in temperature of 10°C (18°F) will double the speed of decomposition. The sun's rays beating down on a spray tank will have some effect on the rate of hydrolysis, and so will constant agitation tend to warm up the spray mixture.

Various pesticide manufacturers have supplied data showing the effect of pH on the half life of their pesticides and is being reported here in table form.

Suprisingly, the insecticides Dursban and Diazinon, although affected adversly by pH, still have extremely long half-lives at high pH's. This is not consistant with what the golf course superintendent is finding in the field. Perhaps resistant strains of insects play a more important part than pH.

On the other hand products like Sevin, Malathion, Dylox (Proxol), and actidione are severely affected by high pH's. Adjusting the pH of the water in the spray tank would most assuredly improve their effectiveness.

Aside from pesticides, there are tremendous amounts of iron, magnesium, and other trace elements being used as adjuvants in spray mixtures. With the exception of boron, which is not truly metallic, all of the metallic salts will undergo hydrolysis at pH above 7 and end up as hydroxides and oxides which are totally inactive. The classic example is ferrous sulfate which hydrolyzes rapidly and will end up as inactive iron oxide rust, sometimes in sufficient amount to clog the sprayers.

When these metals are chelated they become immune to hydrolysis and are totally and completely available to the plant.

Correcting the pH of the water in the spray tank is possible and achievable, but should not be done haphazardly. The accurate way to monitor pH is with a pH meter. But these meters can go haywire unless they are checked and standardized on a daily basis. The use of pH paper is a cruder way of checking pH and will not be accurate within 0.5. But since a pH of between 6.5 to 7 is an acceptable range, one can get by with pH paper.

The one acid that is readily available to everyone is vinegar. It should be carefully added to the water in the spray tank in small increments, checking with pH paper. If too much vinegar is added and the pH drops below 6.5, the pH can be brought back with household ammonia. Always adjust the pH of the water before adding the chemicals to the spray tank.

W.A. Cleary Chemical Corporation has developed a very safe acidifier which also acts as a chelating agent. Although, slightly more expensive, it comes with a supply of pH paper and instructions for use. I don't know of any other chemical company that has a comparable product.

W.A. Cleary's Water Acidifier

	Fluid Ounces to Add to Achieve pH 7			
Water pH	**Gallons of Water to Treat** 50 Gal.	100 Gal.	150 Gal.	200 Gal.
7.1 - 7.5	1	2	3	4
7.6 - 8.0	2	4	6	8
8.1 - 8.5	3	6	9	12
8.6 - 9.0	4	8	12	16

There is an important caution that you must be made aware of: the effect of pH on postemergent herbicides. Specifically, herbicides such as 2, 4-D, MCPP, MCPA, and Dicamba are water insoluble acids that have been put into solution with amines. These solutions are always alkaline, and if they are acidified these herbicides drop out as water insoluble gums, which will foul up the spray tanks. They are best sprayed with the alkaline water. **Never adjust the pH of herbicidal sprays.** However, methylarsonates such as MSMA and DSMA are unaffected by pH.

The best way to conclude is to remind you that unless you carefully and painstakenly adjust the pH of the water within the narrow limit of between 6.5 to 7, it would be better for you to accept the alkalinity of your water and do nothing at all.

Common Name	Chemical Name	pH	Half Life Time
Dylox	Trichlorophon	6	89 hr.
Proxol		7	6.5 hr.
		8	63 min.
Malathion	Malathion	<5	1 hr.
		7	7.8 hr.
		>8	1 hr.
Sevin	Carbaryl	6	100-150 days
		7	24-30 days
		8	2-3 days
		9	3 hr.
		10	20 min.
Betasan	Bensulide	4 (20°)	28+ days
		7	27+ hrs.
		10	21+ hrs.
Diazinon		3	706 min.
		5	31 days
		7	184 days
		9	135 days
		10	6 days
Dursban	Chlorpyrifos	5	63 days
		7	35 days
		8	23 days

Adjusting the pH of your spray tank is a simple procedure. However, adjusting the pH of your soil is a slow arduous task that requires patience and time.

pH In Soil

An alkaline soil is the result of irrigating with hard water containing sodium carbonate and bicarbonates found in some river and well waters.

All nitrogen fertilizers acidify the soil, even though the nitrogen fertilizer you are applying may be alkaline, chemically. Through bacterial and enzymatic action in the soil, nitrogen in the soil combines with oxygen to form nitric acid which acidifies. You could do it all with fertilizer if you could stand the growth that results but that would be prohibitive and impractical.

Your only good source of acidifying is sulfur. It is a necessary element good for the growth of grass but without the over abundance produced by nitrogen.

The popular sources of sulfur are: gypsum, sulfur coated urea, and elemental sulfur. Of the three, elemental sulfur is the most efficient and practical to use. From what I have said before, there is not enough sulfur in the sulfur coated urea to correct the alkalinity unless you use exorbitant amounts of fertilizers. There is nothing wrong with using gypsum until you compare its' efficiency with elemental sulfur. It takes four pounds of gypsum to provide one pound of sulfur. But because gypsum is partially neutralized, I would venture a guess that elemental sulfur is about eight times more effective. Whereas nitrogen oxidizes to nitric acid, sulfur oxidizes to sulfuric acid.

Sulfur itself is inert and non-phytotoxic and when in the soil it slowly oxidizes to sulfuric acid correcting alkalinity and also reducing the sodium content of the soil. We produce a six pound per gallon flowable sulfur which we recommend using one pint per 1000 square feet at two week intervals for six to eight treatments, thereby applying six to seven pounds of sulfur per season to rectify the problem. These treatments are made during the spring and summer. We have not experienced burning even when the temperatures were in the nineties.

W.A. Cleary's Flowable Sulfur

	SULFUR-F, Gallons/1000 sq. ft.		
pH Change	SAND	LOAM	CLAY
8.5 to 6.5	7.7	9.5	11.5
8.0 to 6.5	4.7	5.7	7.7
7.5 to 6.5	1.8	3.0	3.8
7.0 to 6.5	0.3	0.7	1.2

	SULFUR-F, Pints/100 cu. ft.		
pH Change	SAND	LOAM	CLAY
8.5 to 6.5	8	10	12
8.0 to 6.5	5	6	8
7.5 to 6.5	2	3	4
7.0 to 6.5	½	1	1

*All rates indicated are for use on non-turf areas. On areas of fine turf, apply 1 pint in 5-10 gallons of water per 1000 sq. ft. beginning in early spring. Make 3 additional applications during the year. Do not exceed 1 pound sulfur (about 1.3 pints SULFUR-F) per application.

All winter treatments are ill advised, because during that period, irrigation is supplied by nature in the form of rain. During that period the rain acts to flush out the alkalinity and salts.

Acid soils, on the other hand, result from repeated fertilization of turf in areas where the irrigation water is soft and practically salt free. It is generally recognized that soils with a pH between 6 and 6.5 are ideal. Whenever the pH drops to 5 or below, the normal procedure is to lime the soil with limestone (not hydrated lime). The usual procedure is to add about one ton to the acre of powdered limestone. This is a very tedious procedure.

Instead, some applicators are resorting to granular limestone and flowable limestone as a clean, easier procedure. During the spring and summer months, we feel that our 6 lb./gallon flowable limestone is distinctly advantageous, because it is clean to apply and can be sprayed by itself or in mixtures at small integral rates. Because it is micronized it provides instant and uniform pH increase.

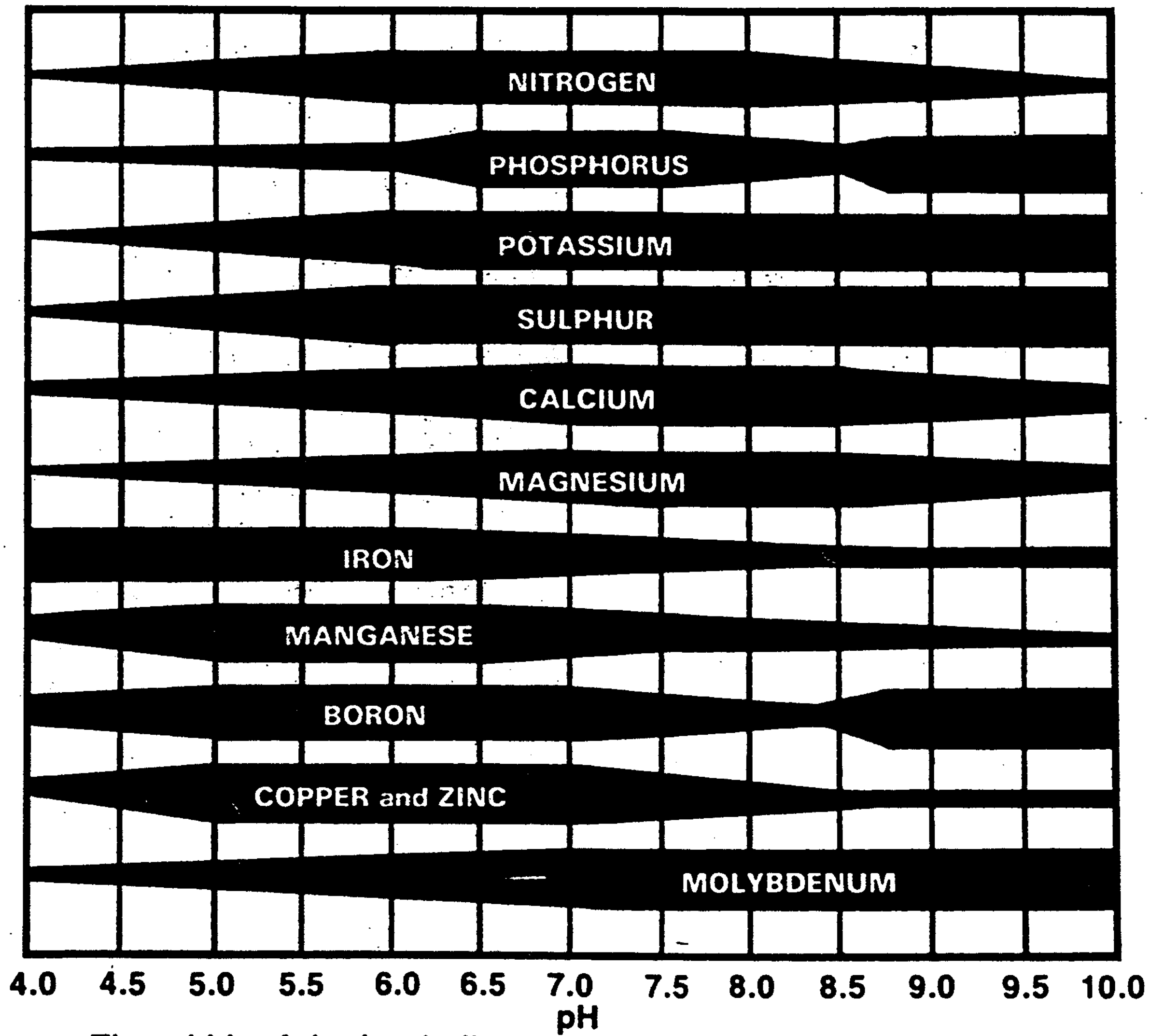
W.A. Cleary's Flowable Limestone

	LIMESTONE-F, gallon/1000 sq. ft.					
	SAND		LOAM		CLAY	
Present Soil pH	to pH 6.0	to pH 6.5	to pH 6.0	to pH 6.5	to pH 6.0	to pH 6.5
4.8	1.00	1.42	1.67	2.33	2.33	3.33
4.9	0.92	1.33	1.58	2.17	2.08	3.08
5.0	0.83	1.25	1.42	2.08	1.92	2.92
5.1	0.75	1.17	1.33	1.92	1.67	2.67
5.2	0.67	1.08	1.17	1.83	1.50	2.50
5.3	0.58	1.00	1.08	1.67	1.25	2.25
5.4	0.50	0.92	0.92	1.58	1.08	2.17
5.5	0.42	0.83	0.83	1.42	0.92	1.83
5.6	0.33	0.75	0.67	1.33	0.75	1.67
5.7	0.25	0.67	0.50	1.17	0.58	1.50
5.8	0.17	0.58	0.33	1.08	0.42	1.33
5.9	0.08	0.50	0.17	0.92	0.25	1.17
6.0	—	0.42	—	0.83	—	1.00
6.1	—	0.33	—	0.67	—	0.83
6.2	—	0.25	—	0.58	—	0.67
6.3	—	0.17	—	0.42	—	0.50
6.4	—	0.08	—	0.25	—	0.33

It would take a number of years to thoroughly correct pH with flowable limestone when applied seasonably at a rate of 50 gallons to acre, incrementally. But one does correct immediately the pH in the thatch and ¼ to ½ inch layer of soil. This procedure provides a pH environment that favors an increase in microbial population, thus reducing thatch and providing also better nutrient and trace element uptake by the lateral roots of the plant.

Here's why pH is important. The illustrated diagram shows how high or low pH affects nutrient availability. The wider the bar graph, the more of the nutrient is available for plant growth.

Effects of Soil Reaction on Availability Of Soil Nutrients to Plants



The width of the bar indicates the relative availability of each element with a change in soil reaction (pH).

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