Are Detergents a Problem to Plant Growers?

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We are concerned with the quality as well as the quantity of water available for growing plants. Our first encounter with the detergent problem on Long Island came in 1961 when several greenhouse operators in the Bellmore-Wantagh area found that their well was foamy when it came from the faucet. Tests showed that the water had from 1 to 2 ppm (parts per million) of alkyl benzene sulfonate (ABS) the active surfactant ingredient in many household detergents. Naturally the growers were alarmed so a survey was taken of water samples from several growers in the area. The amounts of ABS in the water varied from none, in most places, to 1.5 ppm in a few greenhouses. A concentration of 1.5 to 2.0 ppm can cause foaming. The growers had not noticed any harmful effects on plant growth or reduced keeping quality of cut flowers.

Because the ABS in water is associated with a health hazard and the foamy water is unsightly there is considerable political pressure to legislate the non-degradable detergents off the market. There have been many newspaper articles on the subject with titles such as "Senate Combats Water Polution," "State Unit Probes Detergents—Seeks Extension of L.I. Study."

Why are we getting detergents in the water? Washing dishes and clothing with soap in hard water was difficult because much of the soap was used up in softening the water before there was enough to do a cleaning job. Use of soap also left a precipitate or scum. The synthetic detergents (syndets) or cleaning agents came into use shortly after World War II and were much more effective and economical than the soaps previously used. Their popularity has increased to an annual use of 4 billion pounds in 1963. In addition to the surfactant there are other materials called "builders" in the commercially available detergents such as mildly alkaline, complex phosphates that adjust alkalinity and add to soil-suspending power. The soaps previously used were broken down in cesspools, or other sewage disposal units. The ABS is not so readily broken down in sewage treatment plants or streams and rivers and eventually turns up in well water or in water drawn from streams (6). Cesspools and septic tanks do a poor job of breaking down sewage and ABS in particular. The ABS found in well waters in the U.S. varies from 0-2.6 ppm and in river water supplies it varies from 0-5 ppm (11). Although feeding tests showed that the ABS was not particularly harmful to animals when used at rates up to 200 ppm (Tusing), the U.S. Public Health Service set a tolerance of 0-0.5 ppm for drinking water probably because over 0.5 ppm ABS may indicate the water also contains other contaminants that make the water unsafe to drink. Purified ABS is not easily detected by taste at concentrations below 16 ppm or by odor at less than 1000 ppm (2) so that ABS alone is not likely to be the source of bad odors or taste in finished water.

How far can ABS travel in underground water supplies? The ABS from household detergents discharged in sewage is only partially degraded (broken down) so some of it travels with the underground water and eventually shows up in wells. The underground water flows south at 0.5-2 feet per day in southern Long Island (4). The deeper the wells and the further they are away from the source of contamination the less likely the chance of ABS showing up in well water. However ABS occasionally shows up in wells 95 feet deep. Wells 500 feet from launderette cesspools can become contaminated with ABS (5).

The detergent problem cannot be overcome as long as private sewage disposal units and private wells are installed on the same building lots. Industrial wastes, garbage dumps, scavenger wastes, storm sewers and agricultural pollution are also sources of ground water pollution on Long Island and elsewhere.

Table 1 (4) shows a 53% overall contamination in Suffolk County's private wells. The town of Baldwin had 603 private wells tested and 58% showed contamination with syndets. Some of the more sparcely populated areas were not suspected of having contamination and were probably not tested.

Table 1. Syndet occurrence thruout Suffolk County.

October 1959 March 1961	No. of wells tested	No. of wells with syndets	No. of wells without syndets	Wells with syndets (%)	Syndet concentration – ppm 0.02-0.4	0.4-0.9	0.9-1.4	1.4
Babylon	603	347	256	58.0	132	92	72	51
Islip	139	90	49	65.0	52	13	7	18
Huntington	7	1	6	14.3	1	0	0	0
Smithtown	34	8	26	23.5	8	0	0	0
Brookhaven	190	76	114	40.0	49	11	4	12
Riverhead	9	2	7	22.2	1	0	1	0
Southhold	4	1	3	25.0	1	0	0	0
Southampton	19	10	9	52.5	9	0	1	0
East Hampton	3	0	3	0	0	0	0	0
Shelter Island	3	2	1	66.6	2	0	0	0
Totals	1011	537	474	53	255	116	85	81

Improved public sewage disposal may help but this is in the distant future for many parts of Long Island. There is a health hazard from contaminated water but there is very little information on the effects of the ABS on plants.

Some detergents when used in sufficiently high concentration are harmful to plant life. Others used at comparable or lower rates are used as spreaders in spray formulations or are used in irrigation water to reduce surface tension and therefore increase the speed of penetration. Bastos (1) found "Carbowax" at 0.2% (2000 ppm) to be phytotoxic. Rotini, Guerrucci, and Maffel (8) studied the effect of sodium alkylaurylsulfonate, sodium laurylsolfonate and sodium oleate on mitosis (cell division) of onions. There was an inhibiting effect which started at a concentration of 0.025% (250 ppm) and increased with concentration above that rate. The response to sodium

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dioctylsulfonate varied with plant species.

Nonionic wetting agents are sold to growers to reduce the surface tension of water used for irrigation. This is claimed to improve water penetration and movement in the soil and to facilitate the uptake of water and nutrients by plants. These "water wetters" are effective at concentrations of 0.01% (100 ppm) by weight.

Klein and Jenkins (7) studied the effects of ABS on the growth of plants in solution culture and in soil. In solution culture they found greatly decreased growth of sunflowers and barley with increased concentrations of ABS from 0 to 10 to 40 ppm, but less toxicity to sunflowers in unfertilized soil in seven inch pots, and none when the soil was fertilized. They added sewage and found the beneficial effect from the fertilizer outweighed the harmful effects of the ABS. One of their concluding statements was "it may be that plant growth is retarded only in nutrient deficient soil."

The ABS problem may be temporary because industry is developing more degradable detergents which are coming on the market and may be largely replacing the ABS by late 1965. They are developing newer compounds called linear alkylates for use in making biodegradable soft detergents. This does not necessarily mean there will be a decrease in the overall contamination of water supplies by other waste materials.

Experimental Procedure

Does the ABS in the water affect growth of higher plants in greenhouse soil? A standard 54.8% alkyl benzene sulfonate was obtained from the American Soap and Detergent Association. This was used to prepare ABS solutions of 0.5, 2.5, 5.0, 10, 20 and 40 ppm in 12 gallon plastic containers at Farmingdale and 0, 25 and 50 ppm solutions at Ithaca. Expected rates of ABS in a washing machine are 200-600 ppm and in sewage water on a laundry day are 10-12 ppm. These prepared solutions were used to water the soil of bench and pot plant crops for 20 days in one experiment and 5 months in another. Observations were made on root and top growth. The results of the preliminary experiments did not justify further research.

Results

With pot plants there was no consistent reduction in growth or quality of plants related to increases in concentration of ABS. Table 2 shows the relationship of number of leaves and Table 3 height of various pot plants to concentration of ABS. There were no deleterious effects on pot plants at rates over 10 times the highest found in any of the greenhouse water supplies.

Table 2. Effect of ABS solution on number of leaves of pot plants grown 5 months.

Plant	No. of plants	Ave. no. leaves at ppm ABS 0	2.5	5	10	20
Nephthytis afzelii	2	4	6	7	7	4
Philodendron panduraeforme	2	3	5	4	4	5
Dracena sanderiana	2	12	16	14	16	14
Dracena godseffiana	2	9	11	13	10	13
Saintpaulia ionantha	5	32	29	27	29	30

Table 3. Effect of ABS solution on height of pot plants grown 5 months.

Plant	No. of plants	Average height in inches at ppm ABS 0	2.5	5	10	20
Nephthytis afzelii	2	9	7	9	8	7
Philodendron panduraeforme	2	9	9	12	10	10
Peperomia obtusifolia	2	5	6	7	6	6
Dracena sanderiana	2	11	13	12	12	12
Dracena godseffiana	2	10	8	10	9	9

Results with bench crops were not as uniform as with pot plants due to variation in soil and other factors that effect plant growth. Table 4 shows the effect of concentration on the top growth of several crops. The weights are totals of flowers periodically harvested and tops grown from time of planting on December 1 to the conclusion of the experiment in mid May. The results showed no definite trend as to effect of concentration on growth.

Table 4. Effect of ABS solutions in top growth of bench crops grown 5 months.

Plant	No. of plants	Total yield in grams from plots treated with ppm ABS 0	2.5	5	10	20	40
Chrysanthemum	18	782	678.5	509.5	485	398	733
Carnation	18	701	696.5	678.5	561.5	572.5	720.5
Snapdragon	44	2365	1675	1437	1580	1301.5	2702.5
Fuschia	4	178	139	169	166	138	185
Lantana	4	76	24	15	24	22	64

A similar experiment was carried out at Ithaca with *Begonia, Coleus* and carnation grown for 20 days in pots watered with ABS solution at 0, 25, and 50 ppm. The data are summarized in Table 5. There was a slight decrease in growth of *Begonia* but no consistent decreases in growth of *Coleus* and carnation. A similar experiment was carried out in 1964 by a student at the State University Agricultural and Technical Institute at Farmingdale using radish plants grown in soil in pots watered with ABS solutions of 1.0, 20, 40, 100 and 200 ppm. There were no visible differences in the growth of plants receiving the various rates of ABS. The yield of radishes is shown in figure 1.

Table 5. Fresh weight in grams of plants grown in ABS treated soils for 20 days.

Plant	No. of plants	No. of waterings	Average fresh wt. in grams from plots treated with ppm ABS 0	25	50
Begonia Semperflorens	8	3	12.08	10.56	9.85
Coleus blumei	8	5	30.07	25.35	27.68
Dianthus caryophyllus White Sim	8	6	17.21	17.90	16.81

Conclusion

Preliminary experiments showed no consistently adverse effects on the growth of plants in good greenhouse soils continuously treated with ABS solutions much higher than could be expected to occur in water available to plant growers. Other impurities in water are more likely to harm plants than the alkyl benzene sulfonate. Water containing enough ABS to be declared unsafe for drinking

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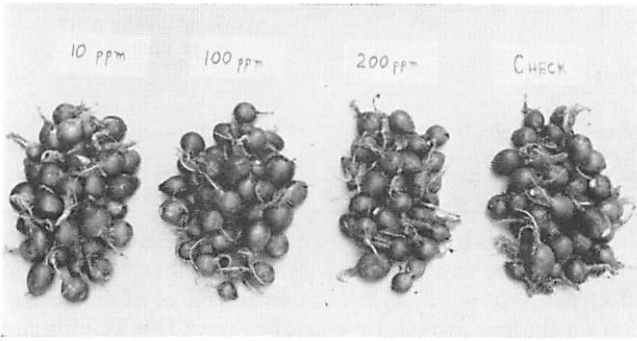

Figure 1 The yield of Radishes as affected by ARS solutions of 10, 100 and 200 ppm.

or cause foaming is probably not harmful to most plants especially if they are grown in well fertilized soil.

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