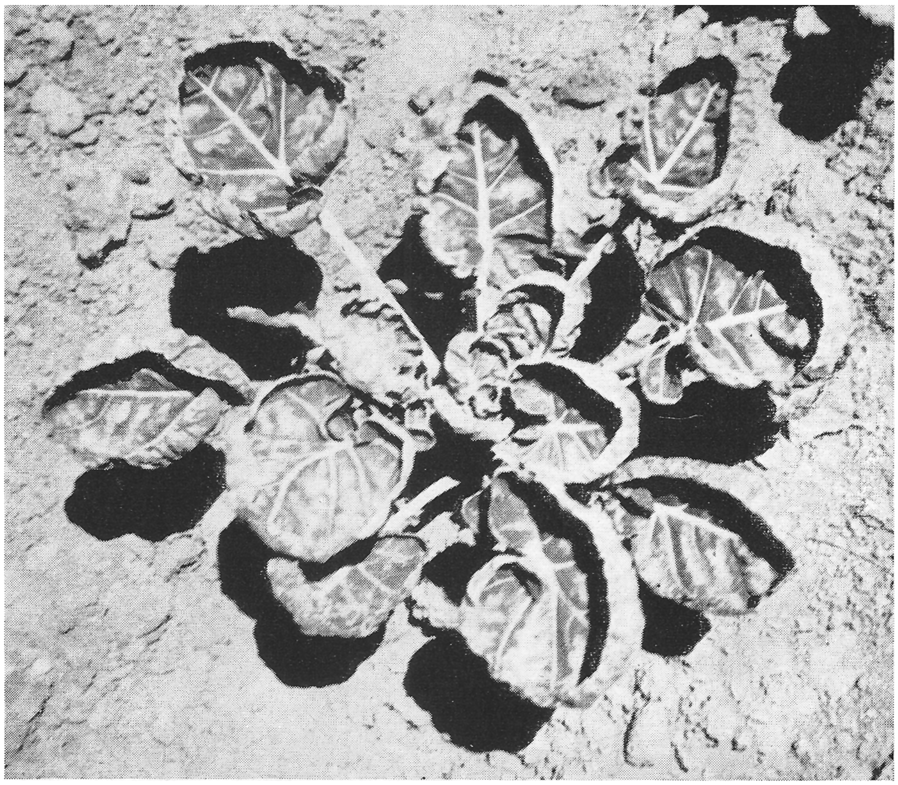
Test crop on acid soil indicates

Manganese Toxicity

may be aggravated by nitrogen

JOHN C. LINGLE and J. R. WIGHT



A Brussels sprout plant showing manganese toxicity caused by heavy applications of ammoniacal fertilizers.

Heavy application of ammoniacal nitrogen fertilizers to acid coastal soils has been suspected of stimulating manganese toxicity of Brussels sprouts.

Ammoniacal nitrogen fertilizers tend to cause a lower soil pH — relative alkalinity-acidity — and make the soil more acid, which in turn usually renders the soil manganese more available to plants. Certain other nitrogen fertilizers such as calcium nitrate tend to cause the soil to become more alkaline, or basic, and have a higher level of soil pH.

To study the effect of the source of nitrogen on the manganese content of plants, test onion plants were grown in the greenhouse in pots containing Elkhorn fine sand, an acid coastal soil from San Mateo County. The soil was taken from a field where Brussels sprouts showed manganese toxicity symptoms.

Growth of Onion Plants on Elkhorn Fine Sand Soil as Influenced by Source and Rate of Nitrogen Fertilizer

Source of nitrogen	Dry weight of onion plants per pot — Pounds nitrogen applied per acre				
	0	100	200	400	Mean
	gms.	gms.	gms.	gms.	gms.
No nitrogen	3.18	...	...	...	.....
Ammonium sulfate	...	2.89	2.65	1.64	2.39_a*
Ammonium nitrate	...	3.19	2.52	2.13	2.61_b
Calcium nitrate	...	3.40	2.50	2.04	2.65_b
Mean	3.18_x	3.16_x	2.56_y	1.94_z	.....

* Means followed by a common subscript letter are not significantly different at odds of 19 to 1.

Onions were selected as a test crop for two reasons: other research workers have reported that heavy nitrogen application on onions increased manganese content in the tissue; and, onions are not susceptible to the sugar beet nematodes known to be in the soil used in the greenhouse tests.

Acid forming ammonium sulfate and ammonium nitrate and basic calcium nitrate were chosen as nitrogen source fertilizers. Each fertilizer was applied at rates of 100, 200 or 400 pounds of nitrogen per acre with a check pot left untreated. The onions were direct seeded in each pot and thinned to 10 plants per pot after germination.

The onion plants were grown until the largest had bulbs of about ¾″ diameter, then harvested, and weighed to determine growth effects. After drying, the manganese content of the dried plant tissue was determined chemically. The soil pH was taken on all pots to determine the effect of different nitrogen sources and the various rates of application exercised on this soil property.

At the time of harvest, the plants which had received the heaviest nitrogen applications were dark green in color, but were stunted and had yellowed and dying leaf tips. Applications of nitrogen above 100 pounds per acre had an adverse effect on growth. Growth of plants in pots receiving nitrogen at the rate of 400 pounds per acre was only half that of those receiving rates of 100 pounds per acre. Sources of nitrogen differed significantly in this respect. Ammonium sulfate prevented normal growth more than either ammonium nitrate or calcium nitrate and their effects were not significantly different.

The Manganese Content of Onion Plants as Influenced by Source and Rate of Applied Nitrogen.

Source of nitrogen	Manganese content of onion plants — Pounds nitrogen applied per acre				
	0	100	200	400	Mean
	ppm	ppm	ppm	ppm	ppm
No introgen	500	...	...	...	...
Ammonium sulfate	...	563	703	923	729_a*
Ammonium nitrate	...	684	741	880	735_a
Calcium nitrate	...	396	801	1000	732_a
Mean	500_x	548_x	748_y	934_z	...

*Means followed by a common subscript letter are not significantly different at odds of 19 to 1.

Feeding trials with dairy cows show

DDT Detectable

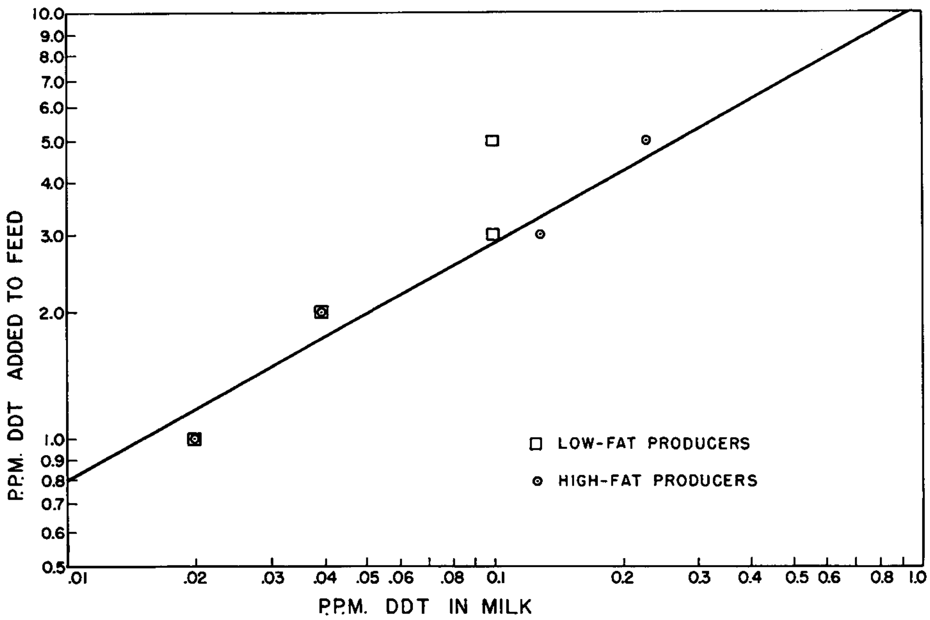
in milk is proportional to DDT in daily feed

G. Zweig, L. M. Smith, and S. A. Peoples

A feeding experiment with dairy cows was conducted in an attempt to define a level of DDT in feeds that would be undetectable in the milk. For six weeks pairs of animals—including producers of both high- and low-fat milks—were fed daily rations containing 0–5 ppm—parts per million—of DDT, based on their feed intake.

In another experiment six cows were fed one ppm of added DDT over a period of eight weeks. Milk was analyzed periodically for fat and DDT content. The maximum level of added DDT in the feed that did not produce a detectable residue in the milk was 0.5 ppm. At levels of 1, 2, 3, and 5 ppm of added DDT, detectable residues were found in the milk of all animals. DDT concentration in milk was proportional to the DDT level in the feed. A correlation between DDT residue and butterfat concentration in milk at each feeding level was found. No such correlation existed between total DDT excretion and total fat production.

Log plot of ppm—parts per million—of DDT found in milk when various amounts of DDT were added to the daily feed.



The amount of DDT added daily to the feed was plotted in logarithms against the concentration of DDT in the milk. Extrapolation of the resulting straight line to 0.01 ppm of DDT in milk—the undetectable amount—gave a value of 0.8 ppm in the feed while the experimental value was 0.5 ppm.

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Manganese concentrations in the plant tissue suggest a reason for the unusual effect of nitrogen. The manganese content of plants receiving nitrogen at the rate of 100 pounds per acre was only slightly higher than those without nitrogen. However, those receiving heavier nitrogen applications contained much higher concentrations of manganese. The different sources of nitrogen did not differ significantly in this respect.

The soil pH, determined on each pot at the end of the experiment, shows that the different nitrogen sources had different soil acidification effects. Ammonium sulfate had a strong acidifying effect—which would in turn make manganese more available to the plant. In contrast, the soil pH was higher where calcium nitrate was used, an effect that should depress manganese concentrations in the plant. Ammonium nitrate produced an effect on the soil pH median to the other two sources. The pH was lowered slightly where it was used, in direct proportion to its ammonium content relative to ammonium sulfate.

Numerous studies have shown that as the soil becomes more acid, manganese uptake by the plant and availability in the soil usually are increased. Other studies have shown that heavy nitrogen fertilization increased the manganese concentration in the tissue, but those studies usually related the phenomenon to lower soil pH caused by ammoniacal fertilizers.

The pH of Watsonville Fine Sand Soil Three Months After the Application of Different Sources and Rates of Nitrogen Fertilizer

Source of nitrogen	pH of soil in pots — Pounds nitrogen applied per acre			
	0	100	200	400
	pH	pH	pH	pH
No nitrogen	4.8	..	..	..
Ammonium sulfate	..	4.7	4.6	4.4
Ammonium nitrate	..	4.9	4.8	4.7
Calcium nitrate	..	4.8	5.0	5.0

The tests with the onion plants indicate that the high manganese concentrations in the plant tissue, as a result of heavy nitrogen fertilization, might be a direct effect of the nitrogen on the plant rather than an indirect effect of such treatment on the soil pH.

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