it seems probable that in some instances the second or third crop grown in fumigated plots may be more severely injured than in untreated plots.

Awl Nematode. The awl nematode, *Dolichodorus heterocephalus* Cobb, is very similar to the sting nematode and similar results may be expected from soil fumigation. There is some indication that the reproduction rate of the awl nematode is somewhat faster than that of the sting nematode, hence populations may be reestablished more rapidly. There is no indication that an unusual build-up of awl nematodes results from soil fumigation.

Several other nematode species are known to parasitize plant roots in Florida and new nematode diseases are being discovered each year. At present we have no proof that populations of any plant nematode other than the stubby root nematode increase above normal expectation as a direct result of soil fumigation.

PLANT RESPONSE TO ALUMINUM SULPHATE

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It is generally considered that the presence of soluble aluminum in the soil is toxic to plants. Considerable work has been done to show that the ill effect of low soil pH is partly or entirely due to soluble aluminum (2, 3, 4, 5, 9, 11, 16, 17, 22, 26). The amounts of aluminum necessary to cause the injury is evidently very small being as little as 5-10 p.p.m. in the soil solution (19). Aluminum is considered a plant poison with as little as 0.5 p.p.m. causing injury in solution cultures (1). The sensitivity to aluminum varies with different crops being greater with such plants as lettuce, beets and less with turnips and redtop (20). Liming gives a favorable response by reducing the amounts of soluble aluminum in the soil (23, 11, 17) while applied phosphorus benefits by reducing aluminum in the soil or in plants (3, 5, 11, 12, 18, 22, 23). One of the benefits of soil organic matter lies in its ability to reduce available aluminum (5, 12).

While most of the work to date stresses the importance of this aluminum as causing negative effects on yield, there is some evidence that in certain cases this element may be beneficial. Small amounts of aluminum in the substrate have increased growth of rhododendron, catawbiense (7), white pine (14), citrus (10, 15), corn (27), millet (29) and cyperus malaciensis (32).

Some of this work points to essentiality of aluminum at least to the Pteridophytes (30) but most of the results can be attributed to side effects. Salts of aluminum have been commonly applied to soils with good effects for such calcifuges as azaleas, rhododendron, and laurel. It has also been used in a limited extent for celery, roses and grapes. The latter were grown on soils of high pH. The beneficial effect of aluminum applications seem to be the lowering of pH with resulting increase in amounts of iron (6, 8, 25).

Other effects attributed to beneficial response of aluminum have been the antagonism to copper (15), the increase of phosphorous in leaves, shoots and roots of citrus (10) and improvement in frost resistance (28, 30).

Recently, the author has observed several instances of favorable plant reaction to aluminum sufficiently to question our present ideas on aluminum applications for soils and plants. The first case involved growth of gladioli on a flatwood sand in Florida. Gladioli growing alongside a ditch showed considerable chlorosis and poor growth whereas the rest of the field was normal. Sometimes ditching will remove shells and other calcareous materials which increases pH. Soil pH readings showed a slightly higher pH value 6.2 in the poor area compared to rest of field which had a pH of 6.0. A deficiency of iron was suspected as being the cause but sprays of ferrous sulfate (0.025%) by weight gave only slight improvement.

Samples of leaves of both chlorotic and normal plants were dried and analyzed spectrographically. Results pointed to a two fold difference in aluminum content being in order of 0.00X% of dry leaves of normal plants as compared to 0.000X% in chlorotic leaves. Subsequent analysis of the soil by a rapid method (31) showed that soils supporting normal growth had 4 lbs. of available aluminum per 2,000,000 lbs. of soil, as compared to 1 lb. per 2,000,000 lbs. of soil in the affected area.

The crop was removed before an application of aluminum could be made. However, it was thought advisable to try the application of aluminum under controlled conditions. Applications of 25 and 100 lbs. of $(Al_2)SO4)_3$-.$18H_2O$ were applied per acre to series of plots on Dade sandy soil. All treatments were in quadruplicate. The pH of the soil at the start of the experiment was 6.4 and the aluminum content was very low being in order of 1 lb. per 2,000,000 of soil. Gladioli, variety Valeria, were grown as test plants.

The bulbs were planted on Dec. 11, 1951. The soil was treated with an equivalent of 1500 lbs. of 4-8-8 fertilizer containing 10 lbs. borax, 20 lbs. Tecmangam, 20 lbs. ferrous sulfate, 10 lbs. zinc sulfate and 10 lbs. copper sulfate per ton.

Almost from the beginning, the aluminum treated plants showed a darker green color than controls. The 25 lbs. per acre treatment gave as good results as the larger application. There was no apparent toxicity even with the higher treatment.

Plants in treated area on March 3, 1952 when photo for Fig. 1 was taken were darker green and more vigorous than controls. The 25 lb. treatment was the best.

Fig. 1. Gladioli grown on Dade sand. CK = check, mixed fertilizer only. A1 = mixed fertilizer plus equivalent of 25 lbs. $Al_2 (SO4)_3.18H_2O$ per acre.

Yield data given in Table 1 indicates that application of aluminum were associated with a small favorable difference in cut flower index.

TABLE 1. YIELDS OF GLADIOLI AS AFFECTED BY ALUMINUM SULFATE APPLICATIONS TO A DADE SANDY SOIL.

Treatment* Lb. per acre	Yield Index**
Check	7527
25 $Al_2(SO_4)$.$18H_2O$	8525
100 " " "	8460

* All plots received equivalent of 1500 lbs. 4-8-8 per acre. Fertilizer contained 10 lbs. borax, 20 lbs. Tecmangam, 20 lbs. ferrous sulfate, 10 lbs. zinc sulfate and 10 lbs. copper sulfate per ton.

** Average sum of indexes for plot. Index obtained by multiplying length of spike in inches by number of florets.

The above indicated that aluminum sulfate in small quantities may be stimulating to gladioli grown on soils of low available aluminum content. However, the mechanism was not at all apparent. To further test the importance of aluminum the following experiment was established in New Jersey:

Chlorotic azaleas, variety Amoena, were potted in Sassafras Gravelly Sandy loam. The soil had a pH value of 5.7 and an available aluminum content of 33 lbs. per 2,000,000 lbs. Plants were treated in quadruplicate with the following sprays:

1. Check, water only
2. $Al_2(SO4)_3$.$18H_2$ (0.25%)
3. " " " (0.50%)
4. Fe SO_4 .$4H_2O$ (0.25%)
5. Fe SO_4 .$4H_2O$ (0.25%) + $MgSO_4$.$7H_2O$ (1.0%)
6. Fe SO_4 .$4H_2O$ (0.25%) + Mg SO_4 .$7H_2O$ (1.0%) + $Al_2(SO_4)_3$.$18H_2O$ (0.25%)

All percentages calculated on weight basis. The plants were sprayed four times on June 4, 1952, July 6, 1952, Aug. 18, 1952 and Oct. 5, 1952.

It was apparent from the first that only sprays containing iron were giving any visual response. The 0.25% aluminum spray gave no response while that of 0.5% showed slight toxicity of leaves indicating that aluminum by itself in concentrations used was of no apparent value.

The iron spray was improved by addition of the Epsom salts indicating magnesium was also deficient. The improvement was also markedly increased by addition of aluminum sulfate to the spray (Fig. 2). Aluminum was responsible for more pronounced and also in longer lasting effects. Iron sprays alone improved chlorosis for a short period only. Im-

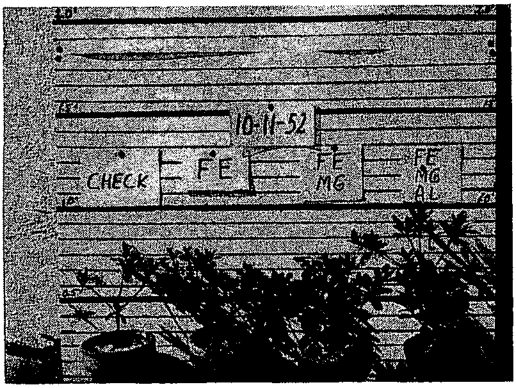

Fig. 2. Azaleas grown in Sassafras Gravelly Sandy Loam. Check = Sprayed with water only. Fe = Sprayed with Fe $So_4.4H_2O$ (0.25%). FeMg = Sprayed with Fe $So_4.4H_2O$ (0.25%) plus Mg $So_4.7H_2O$ (1.0%). Fe MgAl = Sprayed with Fe $So_4.4H_2O$ (0.25%) plus $MgSo_4 7H_2O$ (1.0%) plus $Al_2(So_4)_3.18H_2O$ (0.25%).

provement at any one time was not complete and results had begun to fade by the next application. Where magnesium was added, the color was darker but it too faded rapidly giving rise to revived chlorosis. However, treatment No. 6 with aluminum gave darker green plants. Such color remained fairly well between sprays although there was some loss of color in time.

The results from the second experiment indicate that the value of aluminum may lie in keeping iron in a more available state. The work of Liebig et al (15) would support such hypothesis although they showed that beneficial effect of aluminum was due to its antagonistic effect to copper. Later research (24) has shown that small concentrations of copper to be detrimental because of its effect on available iron.

One of the reasons for poor response to lime on some soils may be due to lowering of aluminum to a point where it affects availability of iron. It has been suggested that high pH values will immobilize aluminum along with iron and manganese requiring additions of all three (13). The soils where this condition can generally exist have low sesquioxide contents. However, for plants such as azaleas, rhododendron etc. that evidently require large quantities of iron, the importance of supplying extra aluminum may be more common and exist on soils with fair amounts of the sesquioxides. Subsequent to these detailed trials, several field experiments were established using 25 lbs. aluminum sulfate per acre for sweet potatoes, tomatoes, cucumbers and gladioli. The amounts of mixed fertilizer varied from 1500-2500 lbs. of 4-8-8. The soils contained less than 2 lbs. of aluminum per 2,000,000 lbs. of soil and the pH was 6.0-6.5. Unfortunately, yield data was not taken, but treated plants were at least as satisfactory as controls. Color of leaves was slightly darker green in several cases in favor of the aluminum sulfate. In the winter of 1952-53 about 200 acres were commercially treated with about 25 lbs. aluminum sulfate per acre for growing gladioli, cucumbers, tomatoes and peppers. In all cases, soils had a pH over 6.0, a low aluminum content and were also fertilized with ferrous sulfate. Yields and appearance of plants were very favorable as compared to plants grown on similar soil but receiving no aluminum.

Data and experience to date point to the beneficial effects of adding aluminum sulfate to the soil in certain cases. It may also have beneficial effects when combined with ferrous sulfate and magnesium sulfate in sprays applied directly to the plant. It remains to be seen whether these responses are widespread.

Summary

The presence of soluble aluminum in soils has generally been considered to be toxic to plants. However, aluminum salts have been applied in the past to soils supporting calcifuge plants with good results, also there have been reports of favorable effects of aluminum by calciphole as well. Applications to be calcipholes have generally been made to lower soil pH and improve iron availability.

The author has observed a favorable response to small soil applications of aluminum sulfate by gladioli grown on Dade Sand. However, aluminum sulfate applied as a spray had no effect on chlorotic azaleas. When combined with iron and magnesium, aluminum sulfate helped correct chlorosis and improved growth. From appearance of plants and performance it is considered that the benefit of aluminum applications lies not in aluminum itself but in its effect upon availability of iron.

It is suggested that small applications of aluminum sulfate might be beneficial for (1) a number of plants grown on soil of low sesquioxide content and a nearly neutral pH or (2) for plants requiring considerable iron and grown on soils of high sesquioxide content.

The application can be made directly to the soil in form of aluminum sulfate or as an aluminum sulfate-iron sulfate spray applied directly to the plant.

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CHARACTERISTICS AND OCCURRENCE OF CERTAIN NEMATODES IN FLORIDA SOILS

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In the past few years usage of the word "nematode" has become commonplace, both to the grower and to the agricultural scientist. Many people are concerned with plant injury caused by nematodes, but few know the nature of these small soil inhabiting organisms. To work with nematodes, it is necessary to distinguish them from rotifers, protozoa, oligochaetes, and other microscopic organisms that inhabit the soil as well as to separate the parasites from similar non-parasitic forms.

Inasmuch as many agricultural workers are not proficient in recognizing parasitic nematodes, it is desirable to acquaint them with the characteristics used by the nematologist in making identifications. When nematode infections are suspected it is of primal importance to have the nematode or nematodes, in question, identified because recommendations for control are becoming increasingly more specific. It is of particular importance for the horticulturist to know what species are present in the soil so that he can select plants that will be poor hosts and thereby discourage the rapid build-up of plant parasitic nematode populations. The grower should also keep in mind that where root-knot nematodes are present nutritional disturbances may then appear in plants (7). On the other hand, research has shown that plants containing a high level of potassium support a larger population of

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