single head, each as much as twelve to fourteen inches across with a delightful fragrance common to all varieties of this plant. The bloom stalks are produced at such frequent intervals as to almost be said to be everblooming.

One of the main objections to this crinum is the large size it attains. Unless used properly it is very apt to grow into rather a monstrosity which would be difficult to remove. It multiplies well vegatatively, and the seed which are formed generously are not at all difficult to propagate.

On the other end of the scale there is the hybrid Ellen or Mrs. Bosenquet, developed at Leesburg. Here the blossom is distinctly lily-form of a burgundy red. This is the darkest of all the crinums we have grown. It flowers but once a year and that is about mid-May or early June.

In between these two is the medium pink J. C. Harvey with wide petals similar to the amaryllis. This type reproduces vegatatively so freely that we have never bothered with seed. The Louis Bosenquet is an even lighter shade than the J. C. Harvey and is quite similar in shape to Ellen Bosenquet. Both prefer a rather moist sunny location.

Another contrast in this interesting family is Crinum giganteum with its pure white tulip formed flowers. This type has been known to thrive well with its roots in water. The sun tends to burn the blossoms to such an extent that it must be grown in at least partial shade; I believe it would even tolerate quite deep shade, although I have never grown it under such conditions.

Perhaps the most spectacular of all the crinums growing in our garden is Crinum amabile. The bloom stalks are a blood red and the flowers, the largest that we grow, have petals with a rosy outside and a lighter stripe in the middle. Quite an erratic bloomer, it is well worth the waiting when it does perform. It is almost sure that a well established plant will offer a show at least some time during the year. It is most apt to bloom in the middle of the fall, just before cooler weather sets in.

Native to the state and growing in all parts is Crinum americanum or Florida swamp lily. This is in many respects similar in its flower to C. asiaticum but distinctly smaller and, in most specimens, less fragrant. Growing at rather great depth, these bulbs have been difficult to bring into civilization for us at least.

From a now forgotten source, we acquired a type of crinum very much like the C. americanum except for the fact that it has much larger and finer blooms. Whether this is a sport originally, or a hybrid, we have never been able to ascertain. It is an interesting question. For lack of a better designation, one of our grower friends, himself quite an authority on crinums, calls it C. americanum variety robusta. This crinum has multiplied so well vegatatively that we have never raised any of the seed which it sets readily. It is quite possible that at least some of these have volunteered and have been credited to vegetative reproduction. If this be true, then if it is a hybrid, its characteristics have become so well fixed as to justify its classification as a separate variety.

STUDIES ON LEAF SCORCH OF GLADIOLUS

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For several years gladiolus plantings in parts of Manatee and Hillsborough Counties have been affected with leaf injury of the tip-burn type. This condition will be referred to as leaf scorch in this report. The symptoms commonly observed in the field are the following: two to three days after a heavy fog, dark water-soaked areas are found near the tip of the leaf and near the margins. During the following week the whole tip area may begin to turn various shades of brown including light tan. The water-soaked areas also tend to assume a tan color in certain varieties. The severity of leaf scorch varies so that a given variety may in different seasons exhibit scorched areas ranging from one to six inches in length.

Information available in the literature indicates that fluorine as an atmospheric contaminant might possibly be the cause of this leaf scorch. Investigations (1, 2, 3) reported from other states have indicated that the gladiolus plant is unusually sensitive to fumigation in-

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jury from volatile fluorine compounds but that varieties differ considerably in susceptibility. Recently, workers in the State of Washington (3) have adopted the Ethel Cave-Cole variety of gladiolus as an indicator plant for atmospheric pollution by fluorine. The degree of contamination is determined by leaf-tip analysis and the extent of characteristic tip-burn.

The symptoms of rather severe injury of gladiolus known to be due to volatile fluorine compounds (1, 2) are the following: leaf-tips and margins turn grayish-green the second day following exposure. By the third day the leaves turn grayish-white or tan under severe fluorine treatment. At the end of a week the damaged area has a burned appearance with tan to dark brown color. The outstanding leaf symptom is the light tan discoloration with dark brown margin. Sheathing leaves tend to turn uniformly dark brown. Petals and floral bracts may also be scorched marginally.

Johnson et al. (1) point out that physical appearance is inadequate to identify fluorine injury to plants and that the symptoms must be correlated with other facts, including abnormally high fluorine content of leaf tissue. These workers conducted fumigation trials using hydrogen fluoride gas in sealed chambers with gladiolus plants of five varieties including Snow Princess and Picardy. The control contained 2 ppm fluorine and three samples of leaf-tips from treatments that did not cause leaf scorch contained 5, 8 and 8 ppm fluorine on a dry weight basis.

Slight leaf scorch occurred when 22 ppm of fluorine was present and some scorch was found with two samples containing 24 and 35 ppm fluorine. Considerable leaf scorch occurred with plants that had leaf-tips containing 95 ppm fluorine. Slight to severe injury was found, however, in field samples that contained 15 to 115 ppm fluorine in one case and 138 to 611 in another case. This indicates in at least one case that only slight injury was found when as much as 138 ppm fluorine was present. Three samples of field-grown gladiolus were obtained from Florida in 1948 by Johnson and co-workers. One sample, described as healthy, contained 6 ppm fluorine; another sample described as having medium leaf scorch contained 27 ppm; and a third sample having severe leaf scorch contained 52 ppm fluorine. Many of the leaf samples taken from gladiolus plants apparently suffering from leaf scorch in the field in the State of Washington had fluorine contents in the range of 200 to 611 ppm.

Laurie, et al. (2) also fumigated Picardy gladiolus with volatile fluorine compounds in closed chambers. They reported that leaf injury was obtained in some cases when the fluorine content of leaf-tips was in the range of 5 to 20 ppm. Untreated check plants contained 1.6 ppm fluorine. The authors attempt to explain the occurrence of fluorine injury when leaf-tips accumulated only relatively small amounts of the element by saying that exposure to high concentrations of fluorine for short periods of time may cause severe injury even though relatively small amounts of the element are absorbed by the plants, while exposure to lower concentrations of fluorine for long periods of time may cause considerable amounts to accumulate in leaves with only slight or moderate damage. These workers feel that it may be advisable in diagnosing fluorine injury to gladiolus plants to correlate both the time and concentration factors of exposure with the extent of injury and subsequent fluorine content of leaf tips.

This report is an account of studies undertaken a year ago in an effort to determine the cause of leaf scorch and to collect data on factors affecting its development. A summary of this work was included in the Annual Report of the Florida Agricultural Experiment Stations for 1953 (4).

Experimental Methods

Snow Princess, Bloemfontein, and Picardy gladiolus were planted in two-gallon glazed pots and moved into gladiolus fields in selected areas. Two of the areas, Ruskin and Sun City, are subject to leaf scorch of gladiolus while the third, Fort Myers, is not. Two soils were used, one from Fort Myers and the other from Sun City, to determine whether soils might contribute to injury. Thus three varieties, two plants per pot, were grown in two soils at three locations using three replications of treatments.

Corms were planted November 15, 1952 and two weeks later the pots were placed in the fields at the three locations so that the potted plants were on a level with field plants. Pots were watered by hand with the same water used to irrigate the field. Fertilizer was applied as the need was indicated by conductivity tests of composite soil samples collected periodically. Complete fertilizer, 3-8-12

and 4-8-8, containing secondary and minor elements was used. The potted plants were sprayed during field operations, the same as field plants.

Soils, corms, and water used for irrigation and spraying were analyzed for fluorine content and the results are presented in Table 1.

TABLE 1.

Fluorine Content of Soils, Spray and Irrigation Water, and Corms

Sample	Fluorine Content, PPM
Sun City Soil	43
Fort Myers Soil	31
Sun City Spray Water	0.88
Sun City Irrigation Water	0.29
Ruskin Spray and Irrigation Water	0.96
Fort Myers Spray and Irrigation Water	1.82
Snow Princess Corms	26
Bloemfontein Corms	28
Picardy Corms	37

It appears from these data that the materials listed do not constitute a serious source of contamination. Fort Myers water was higher than the others in fluorine, but as will be seen later, this did not seem to cause high fluorine contents of gladiolus leaf tissue from Fort Myers that would unduly affect comparisons.

The first cases of leaf scorch occurred December 25 at Ruskin and December 27 at Sun City. Leaf-tip samples were taken January 5 and 6 and the results of analyses for fluorine are shown in Table 2 along with results from other samplings of leaf-tips. It is evident that the leaf tissue from Fort Myers had less fluorine than the tissue from Ruskin and Sun City.

TABLE 2.

Fluorine Content, PPM Dry Weight, of Leaf-tips of Gladiolus Plants Grown in Pots with Two Soils at Three Locations

	Fort Myers		Sun City		Ruskin	
	F*	S*	F	S	F	S
January 5 and 6						
Snow Princess	12	22	33	38	—	71
Bloemfontein	14	9	21	24	—	112
Picardy	16	11	30	49	—	98
February 4 and 5						
Snow Princess	Trace	Trace	53	17	48	26
March 9						
Snow Princess	23	37	281	24	94	97
Bloemfontein	33	25	112	22	48	76
Picardy	30	Trace	12	65	48	99

* F Fort Myers Soil.
S Sun City Soil.

Leaf scorch was again encountered January 31 and February 1, 1953 and Snow Princess plants at all three locations were sampled February 4 and 5. The results of analyses for fluorine content (Table 2) show that the samples from Ruskin and Sun City had considerably greater fluorine content than did those from Fort Myers, the latter showing only a trace. A finding of *trace* fluorine content indicates the presence of 2.5 ppm fluorine or less and trace will be averaged as 2.5 ppm for the purposes of this report.

On March 6, all plants were returned to the Gulf Coast Experiment Station where the final leaf samples were taken on March 9. The analytical data for this date in Table 2 indicate greater variability in fluorine content than was found when the plants were younger. It is believed that this is due partly to aging and partly to effects of some cases of fusarium infection. It is, however, apparent that the samples from Fort Myers were relatively lower in fluorine content at the final sampling.

Observations of the reactions of the three varieties growing at Sun City and Ruskin indicated that Snow Princess is most susceptible to leaf scorch, Picardy is intermediate and Bloemfontein is least subject to leaf scorch. Figures 1 and 2 are photographs of leaf tips removed from the plants at the sampling in January. Both photographs represent Snow Princess grown in Fort Myers soil. Leaf-tips in Figure 1 are from the Fort Myers location

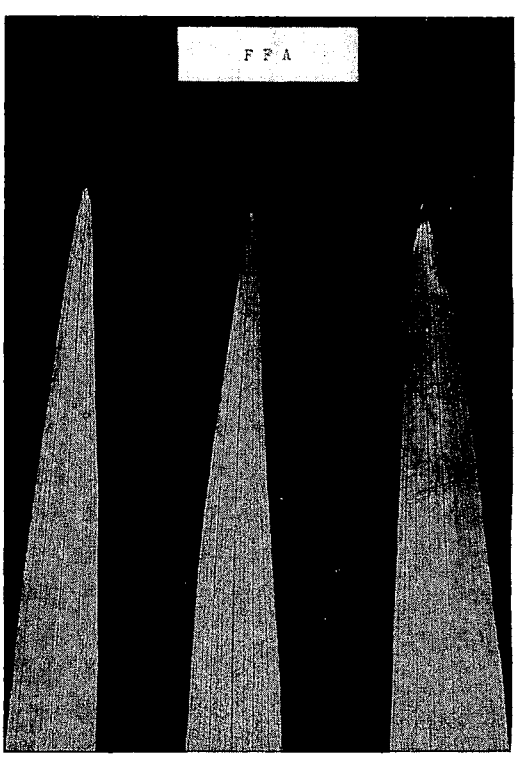

Figure 1. Leaf-tips taken on January 6, 1953 from Snow Princess Gladiolus Plants Grown in Pots of Fort Myers Soil at Fort Myers.

and those in Figure 2 are from Sun City. Figure 2 illustrates tip-burn injury of the type referred to as leaf scorch. Leaf scorch found in the field in Manatee and Hillsborough Counties may be more or less severe than the example shown.

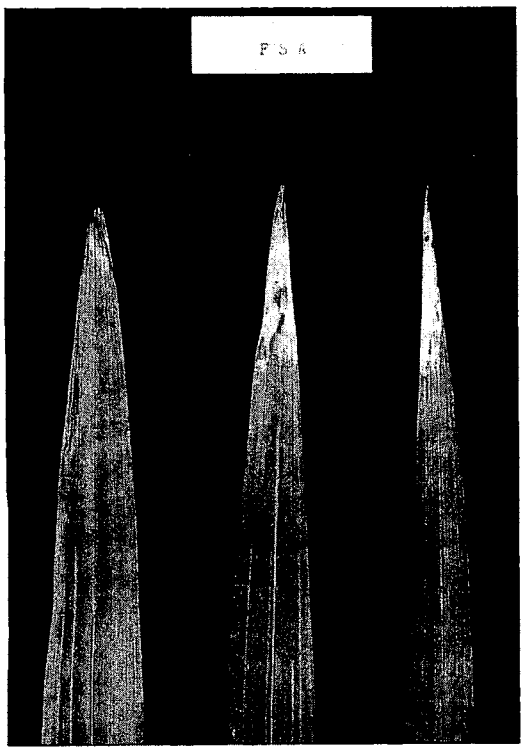

Figure 2. Leaf-tips taken on January 5, 1953 from Snow Princess Gladiolus Plants Grown in Pots of Fort Myers Soil at Sun City.

Discussion

The data in Table 2 were averaged in a manner to permit comparisons between the effects of soil, variety and location on the fluorine content of leaf tips. For each comparison only comparable data were included. The average fluorine content of leaf-tips from Fort Myers soil is 50.6 ppm and for Sun City soil, 35.9 ppm. Thus, the average for Fort Myers soil represents about 41 percent higher fluorine content. The averages for varieties are: Snow Princess, 66.5, Bloemfontein 45.1 and Picardy, 41.9 ppm fluorine content. Snow Princess leaf tips with the highest fluorine content, therefore, contained an average of 59 percent more fluorine than Picardy leaf-tips which had the lowest fluorine content.

The averages for locations are: Fort Myers, 18.0, Sun City, 63.4 and Ruskin, 74.3 ppm. Accordingly the highest average, for Ruskin, is 316 percent greater than the lowest, for Fort Myers. The average fluorine content for Sun City is 252 percent greater than the average for Fort Myers. Thus, it appears that the location at which the plants grew was more important than soil or variety in determining fluorine content.

Since toxic limits for fluorine content of leaf tips of various gladiolus varieties have not been established, it cannot be concluded that fluorine contamination is the cause of leaf scorch of gladiolus encountered in Hillsborough and Manatee Counties. It is possible that other factors related to location or the atmosphere may be at fault or at least contributory.

Summary

Preliminary studies on leaf scorch of gladiolus suggest that this physiological disorder may be due to fluorine compounds present in the atmosphere. Data presented indicate that gladiolus leaf tips accumulated greater amounts of fluorine at Sun City and Ruskin than at Fort Myers. Higher fluorine contents of the plants at Sun City and Ruskin was associated with leaf scorch which was not found at Fort Myers where the fluorine content of leaf tips was lower. The evidence indicates that leaf scorch may have been caused by fluorine compounds, but no definite conclusions can be drawn from these preliminary studies. The possibility still exists that other factors related to location or the atmosphere may be partly or wholly at fault in causing leaf scorch of gladiolus.

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