Brown Tip of Gladiolus Induced by Applications of Fertilizer Materials[1]

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Abstract. **Exposing gladiolus plants to ozone in a closed chamber, to strong winds produced by fans, or to leaf mutilation at the base did not result in any serious leaf injury. Sodium nitrate or potassium chloride applied on exposed roots caused the development of necrotic leaf tips. Superphosphate dusted lightly on the leaves caused severe brown tip.**

Brown tip or tipburn of gladiolus *(Gladiolus grandiflorus)* is a common disorder wherever this plant is grown commercially in the United States. The tips of the leaves turn brown or reddish brown, depending upon the cultivar affected, and in severe cases the brown area may extend down from the leaf tips as much as 5 to 6 inches or more. Sometimes the necrotic areas are on one or both sides of the leaves while the remaining portion of the leaves is green.

Many causes of brown tip have been suspected, and a number have been verified. Hendrix and Hall (2) reported the sensitivity of gladiolus cultivars to fluorides in a fluoride-polluted atm in Washington. They found that all were sensitive to fluorides but that some were more affected than others. Hitchcock, Zimmerman and Coe (3) summarized the results of 10 years' work with fluoride compounds on the growth and development of gladiolus. They showed that tip burn resulted from fumigations with hydrogen fluoride which varied considerably with cultivar and age of plant and leaf. This injury also occurred in control plants exposed to fluorides in the atm.

Commercial plantings of gladiolus nearly always develop a small amount of brown tip (up to ½ inch) during the growing season and this is considered to be "normal." When the necrotic areas extend more than 1 inch down from the leaf tips, and if the plants have not been exposed to fluorides in the air, an examination usually shows that the roots have been injured. This may result either from a severe disease condition, where few roots survive, or from a less severe type of injury where the major portion of the root system appears to be normal but the root tips have been killed.

Sometimes brown tip occurs even though there may be little or no root injury and no evidence of the presence of any airborne contaminants from industrial plants. Brown tip is found in plantings in rural areas of North Carolina as much as 30 miles from any large town or industrial plant. It can be severe in one field while an adjoining field of plants of the same age and cultivar may have practically none. This is a strong indication that in these cases it is not caused by fluorides in the air.

Jenkins (4) listed some of the causes of brown tip in plantings near Castle Hayne, N. C. These included deep cultivation which cut many roots, diseases or nematodes causing injury to the roots, improper fertilizer usage, and water-saturated soil either from irrigation or from heavy rains. It was concluded that brown tip usually appears following any injury to the roots of the plants. Later experiments with 8 minor element combinations (5) indicated that none of those tested prevented brown tip or reduced the severity of the symptoms.

In 1965 Engle et al. (1) reported that ozone in the atm caused tipburn of onions. This appeared to be a possible cause of the tipburn of gladiolus sometimes observed following severe storms which was thought to result from the soil having become waterlogged.

To determine possible causes of brown tip other than those previously reported, greenhouse tests were conducted which included the exposure of gladiolus plants to ozone in a closed chamber; exposure of plants to strong winds to simulate the effects of wind storms that might injure the leaves; cutting parts of the leaves to approx certain kinds of insect injury; and dusting leaves or roots with fertilizer materials to determine if side-dressing operations would cause brown tip.

Ozone Test. Plants of the 'White Friendship' cultivar, 12 inches tall, were exposed to ozone in a closed chamber for periods of 2, 4 and 8 hr. The ozone was produced with an electric generator and introduced into a closed chamber. No provision was made for determining the exact concn but the generator was set at a rate which produced a strong odor of ozone, and the "rubber band" test was used. This consisted of placing rubber bands with the plants in the fumigation chamber and checking them at 1/2 hr intervals. They deteriorated and could be crumbled into small, dry pieces after 4 hr exposure. It was assumed that gladiolus plants would show injury under these conditions if they were sensitive. Further experiments, using more accurate methods of measuring concn of ozone, were planned if ozone injury occurred in the preliminary experiments. However, none of the plants showed injury from ozone under the conditions of the test. Growth was normal until the plants were discarded after they had bloomed. As a result of these tests it was concluded that ozone in concn normally occurring in the atm probably does not cause brown tip of gladiolus.

Leaf Cuts. Cuts were made in selected leaves when the plants were 3- to 4-inches tall to determine if injury to lower portions of a leaf, such as might result from leaf-feeding insects, would cause a necrosis of the tips or the margins of the leaves. The cuts were made near the bases of the leaves and extended either 1/4 or 1/2 through each leaf. No necrotic area had developed on any of the cut leaves, either above or below the cuts, by the time of flowering. This was true even though the cuts severed the vascular bundles and thus prevented the upward movement of water in those areas of the leaves.

Wind Tests. Gladiolus plants in pots were placed in such a way that many of the leaves touched each other. A large electric fan was placed close enough to the plants to cause them to whip around in a manner similar to the effects of gale force winds. Different groups of plants were exposed to these wind conditions for periods of 8, 12 and 24 hr and were examined periodically after treatment.

No injury was observed after a period of 30 days except in the case of the plants that received the 24 hr treatment. These developed small, brown irregular areas at some of the points where one leaf rubbed against another. High winds alone over periods of 8, 12 and 24 hr apparently cause little injury to gladiolus, probably because the leaves are relatively tough.

Test of Fertilizer Materials. Sodium nitrate, potassium chloride, or superphosphate was applied to root areas or to the foliage of plants growing in a greenhouse to determine if brown tip might result from the improper application of fertilizer materials. Each material was applied by removing the

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plant from the pot and dusting the exposed roots so that they were lightly coated with the material. The plant was then returned to the pot. The ball of soil and roots was not disturbed.

In replicated foliage tests the material being tested was dusted lightly on moist plants so that a very fine deposit was left on the leaves in a 2 inch band 6 to 8 inches down from the leaf tips. In a 2nd test a light dust was applied in a 2-inch band across the 4th and 5th leaves of sets of 4 plants each. The leaves were dry and were kept dry. Each material was dusted on lightly and the leaves were then tapped to shake off any surplus. Similar tests were conducted in replicated plots of field-grown 'Friendship' gladiolus.

One to 2 inches of brown tip appeared on the leaves following the nitrogen and potassium applications on the root areas but only 1/4 to 1/2 inch of brown tip resulted from the application of superphosphate to the roots. The results were different when the materials were applied on the leaves. The nitrogen and potassium compounds adhered very little to the dry leaves and caused no apparent injury. The application of these materials on wet leaves resulted only in a localized "burning" of the leaf tissues. However, superphosphate caused from 1 to 2 inches of brown tip on each treated dry leaf within 7 to 10 days. When it was applied on wet leaves the injury was more severe and up to 5 inches of brown tip occurred. Even the lightest coating of this material on either wet or dry leaves resulted in the development of necrotic leaf tips.

Since commercial superphosphate contains fluorides, compounds to which the gladiolus is extremely sensitive, it was considered probable that the injury observed was due to fluorine which was absorbed from the superphosphate by the leaves of the plants. A similar effect occurs when either cryolite or sodium fluosilicate is applied on the leaves of gladiolus. The uptake of fluorine by the roots of the plant is probably slow and may not occur to any significant degree (6) except when superphosphate is applied at a very high rate (2 tons or more per acre) (7). This may explain why little brown tip occurred following the relatively light applications of superphosphate on the root areas of the plants.

Side-dressings of fertilizers containing superphosphate might cause brown tip if methods of application are such that small amounts of the fertilizer fall or blow onto the leaves of the plants. Brown tip can also be expected to appear following relatively heavy applications of nitrogen and potassium fertilizers as side-dressings if these materials are not correctly applied, allowing them to come into direct contact with the roots of the plants.

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Response of Easter Lily to Bulb Treatments of Precooling, Packing Media, Moisture, and Gibberellin[1]

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Abstract. **'Harson' lily bulbs were precooled at 45 to 50°F for 0, 2, 4 and 6 weeks in damp peat (68% moisture) or dry peat (8% moisture) and then soaked for 2 hr in a 900 ppm solution of GA or tap water prior to forcing. Bulbs precooled in damp peat for 4 to 6 weeks had the shortest stems and earliest flowering. Four weeks precooling in damp peat hastened stem emergence and flowering but reduced flower no. as compared to those precooled 6 weeks in dry peat. Bulbs GA treated and precooled 2 weeks flowered about 4 weeks earlier without a decrease in flower no. compared with bulbs precooled for 0, 2, 4 and 6 weeks. Bulbs precooled 4 weeks in dry peat and treated with GA emerged and flowered as early as those precooled in damp peat for 4 weeks without GA or those in dry peat 6 weeks with or without GA. GA treatment hastened flowering similar to that caused by precooling in damp peat.**

Commercially forced Easter lily (*Lilium longiflorum*, Thunb.) bulbs are precooled to stimulate them to flower in a practical length of time. As precooling time is increased, both flower no. and time to flowering are decreased (2). Stuart (6, 7) found that earliest flowering of mature bulbs was obtained following storage at 45 to 50°F in moist peat for 5 to 6 weeks.

All or part of the chilling requirement of many kinds of plants has been replaced experimentally by treatment with gibberellins (8). Aung and DeHertogh (1) found increased gibberellin-like activity in cold-treated tulip bulbs. Rappaport et al. (5) found that sprouting of newly dug potatoes was hastened 2 to 3 weeks when tubers were immersed in gibberellic acid solutions. However, Marth et al. (3) found no apparent response of onion bulbs or gladiolus corms soaked for 17 hr with 1, 10 or 100 ppm GA, and Martin (4) found no marked responses on growth or flowering of lily bulbs soaked 15 min in 1/10, 1, 10, 100, or 1000 ppm GA nor plants sprayed with 10, 100 or 1000 ppm when 2 inches tall and at the intermediate bud stage.

The study reported here was undertaken to determine if prolonged soaking in a high concn of GA could replace all or part of the precooling requirement of Easter lily bulbs.

On August 1, 1967, uniform 'Harson' lily bulbs[3], 5 to 6-inch grade, were selected and treated as shown in Table 1. Treatments consisted of 5 bulbs each and were replicated 6 times in a randomized block design.

Bulbs for precooling were packed in damp peat moss (68% moisture by weight) and dry peat moss (8% moisture) and stored in a standard, thermostatically controlled refrigerator. Precooling treatments consisted of 0, 2, 4 and 6 weeks at 45 to 50°F. Following

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