

Injury to cut flowers of gladiolus by fluoridated water

F. SPIERINGS

Institute of Phytopathological Research (IPO), Wageningen

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Abstract

The fluorine compound in fluoridated drinking water caused injury to the leaf tips as well as to the leaves and bracts of flower stalks of gladiolus, when cut leaves or cut flowers were placed with their bases in the water.

In all cases the fluorine content of 4 cm long leaf tips was much higher when fluoridated water was used in place of non-fluoridated water.

Introduction

At present fluoridation of drinking or tap water (1 ppm F, introduced as Na_2SiF_6) is practised in several municipalities in The Netherlands. Because air pollution with hydrogen fluoride (HF) is known to be detrimental to some plant species and especially to some varieties, it was thought that fluoridation of drinking water might be harmful to some plants if used for watering. Fluorine could accumulate in leaves during water transpiration.

Gladiolus plants, cv. 'Snowprincess', were used because they are known to be sensitive to low concentrations of HF in the atmosphere (Spierings, 1959). Leaf tips become ivory white and necrotic as the result of an 8 hour treatment with HF at a concentration of 15 mm^3 per m^3 air (15 parts per billion).

This report describes experiments on the influence of fluoridated and non-fluoridated tap water on single leaves and cut flowers placed in the two types of water.

Materials and methods

From gladiolus plants 'Snowprincess' grown in a glasshouse, leaves were cut and put with their bases in fluoridated water (water no. 1) and in non-fluoridated water (water no. 2).

Cut leaves from the same variety grown in the field, were treated in the same way with fluoridated water (water no. 1) and with another non-fluoridated water (water no. 3).

Cut flowers of the varieties 'Snowprincess', 'Oscar' and 'Mary Housley' were placed in fluoridated water (no. 1) and in non-fluoridated water (no. 3).

The results of analyses for certain components of the three types of drinking water

Table 1. Some components of the fluoridated and non-fluoridated water.

Conductivity (microsiemens)	Water no. 1 (fluoridated) 160	Water no. 2 (natural) 695	Water no. 3 (natural) 440
pH	8.0	7.9	7.3
Ca mg/l	27.0	93.0	76.9
Mg mg/l	3.0	9.0	5.0
SO ₄ mg/l	10.0	68.5	25.0
Cl mg/l	6.5	115.0	43.0
F mg/l	± 1	0.24	0.08

Tabel 1. Enkele componenten van het gefluorideerde en niet-gefluorideerde water.

are given in Table 1. The samples for analysis were taken during the period that the fluoridated and non-fluoridated water were being used for the experiments.

The fluorine analysis of portions of leaves was carried out with the Technicon Auto-Analyzer. The pretreatment was done as follows: The leaf samples were dried for 48 h at 85°C. After grinding, 0.5 g was weighed and ashed at 500°C for 7 h. Then sodium hydroxyde pellets (2.5 g) were added and the sample fused at 500°C for 8 min. After cooling, the mixture was dissolved in deionized water. The samples were transferred to test tubes and then put in the Technicon AutoAnalyzer. The successive sampling, digestion with H₂SO₄, colorimetric measuring with lanthanum nitrate-alizarine mixture at pH 4, and recording were done automatically.

Results

In a preliminary experiment carried out with cut leaves put with the bases in fluoridated water (no. 1) and non-fluoridated water (no. 2) clear differences showed up after three days (Fig. 1).

In a second, more informative experiment fluoridated water (no. 1) and non-fluoridated water (no. 3) were used. The leaves came from thirty 'Snowprincess' plants grown at Breezand, a small village with little or no HF air pollution. Two days after the experiment started (24th August) the leaves standing in fluoridated drinking water showed more injury of the tips than those standing in the non-fluoridated water (water no. 3). The experiment ended after four days. The average length of injured leaf tips in the fluoridated water (no. 1) was 21.2 mm, while the corresponding figure for the leaves in non-fluoridated water (no. 3) was 9.5 mm (Fig. 2).

The leaves were then analysed for their fluorine content. The top section of the leaves (0-4 cm) and the next section (4-10 cm) were analysed separately since, as had been found earlier, fluorine appears to accumulate in the tips. Table 2 gives the results.

The third experiment was carried out with flower stalks of three gladiolus varieties, viz. 'Snowprincess', 'Oscar', and 'Mary Housley'. All plants were grown at Breezand and cut just above soil level. The two oldest leaves were removed. Nine of the flowering stalks were placed in fluoridated water (no. 1) and nine in non-fluoridated water (no. 3). The flower bracts of 'Snowprincess' in water no. 1 were injured after 4 days.

Fig. 1. Leaf tips of the gladiolus variety 'Snowprincess'. Left: after 3 days in fluoridated water no. 1.; right: after 3 days in non-fluoridated water no. 2.

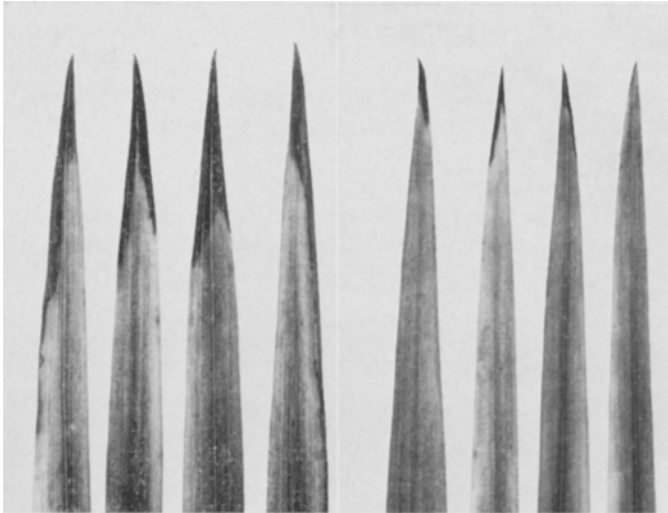


Fig. 1. Bladstukken van het gladioleras 'Sneeuwprinses'. Links: na 3 dagen in gefluorideerd water no. 1; rechts: na 3 dagen in niet-gefluorideerd water no. 2.

Fig. 2. Leaf tips of the gladiolus variety 'Snowprincess'. Left: after 4 days in fluoridated water no. 1; right: after 4 days in non-fluoridated water no. 3.

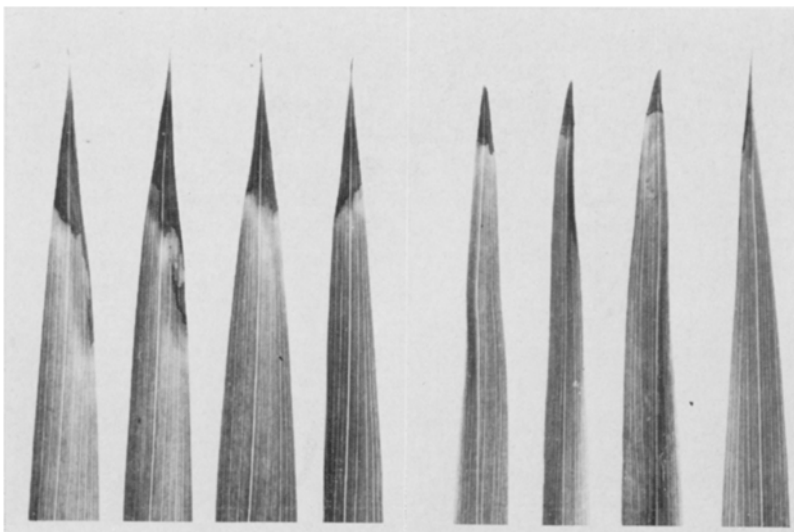


Fig. 2. Bladstukken van het gladioleras 'Sneeuwprinses'. Links: na 4 dagen in gefluorideerd water no. 1; rechts: na 4 dagen in niet-gefluorideerd water no. 3.

Table 2. Fluorine concentration of leaf sections of gladiolus 'Snowprincess' after 4 days in fluoridated and non-fluoridated water.

Variety	Type of water	Length of leaf section (cm)	Date	Fluorine concentration (ppm) ¹
'Snowprincess'	water no. 1. (fluoridated)	0-4	26-8-68	89
		4-10	26-8-68	8
'Snowprincess'	water no. 3 (non-fluoridated)	0-4	26-8-68	13
		4-10	26-8-68	0.2

¹ ppm = parts per million on a dry basis (48 h period at a temperature of 85°C).

Tabel 2. Fluorgehalte van bladstukken van gladiolen 'Sneeuwprinses' na verblijf gedurende 4 dagen in gefluorideerd en niet-gefluorideerd water.

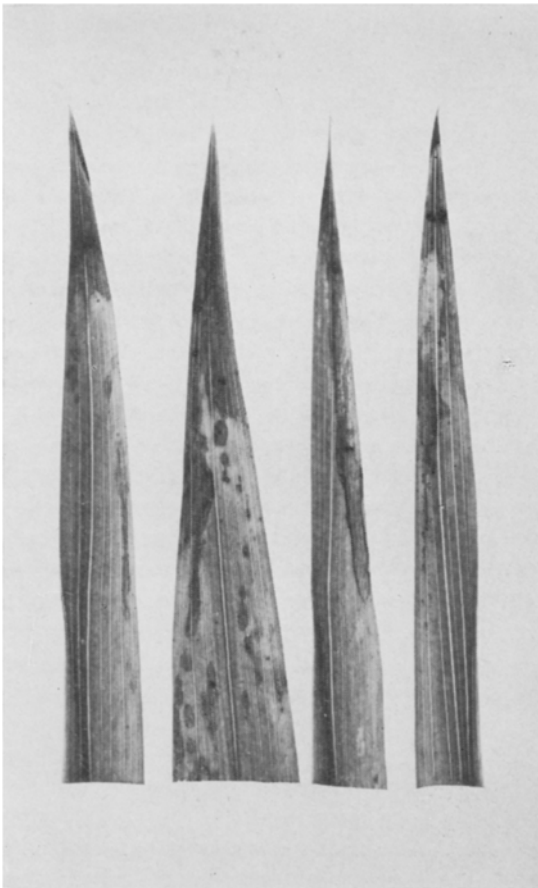


Fig. 3. Leaves from the flowering stalks of the gladiolus variety 'Snowprincess' injured after the stalks had been placed in fluoridated water no. 1 for 4 days.

Fig. 3. Bladeren van bloeistengels van het gladioleras 'Sneeuwprinses' die beschadigd werden nadat deze bloemstelen 4 dagen in gefluorideerd water no. 1 hadden gestaan.

Table 3. Fluorine concentration of leaf sections of three gladiolus varieties before and after stay in fluoridated and non-fluoridated water.

Variety	Origin of water	Length of leaf section (cm)	Date	Fluorine concentration (ppm) ¹
'Snowprincess'	—	0-4	29-8-68	12
	(as picked)	4-10	29-8-68	2
'Snowprincess'	water no. 3	0-4	3-9-68	17.5
	(non-fluoridated)	4-10	3-9-68	4.5
'Snowprincess'	water no. 1	0-4	3-9-68	91
	(fluoridated)	4-10	3-9-68	14
'Mary Housley'	—	0-4	29-8-68	10.5
	(as picked)	4-10	29-8-68	0.2
'Mary Housley'	water no. 3	0-4	9-9-68	29
	(non-fluoridated)	4-10	9-9-68	2
'Mary Housley'	water no. 1	0-4	9-9-68	105
	(fluoridated)	4-10	9-9-68	8
'Oscar'	—	0-4	29-8-68	18
	(as picked)	4-10	29-8-68	3
'Oscar'	water no. 3	0-4	9-9-68	28
	(non-fluoridated)	4-10	9-9-68	2.5
'Oscar'	water no. 1	0-4	9-9-68	72
	(fluoridated)	4-10	9-9-68	4.5

¹ ppm = parts per million on a dry basis (48 h period at a temperature of 85 °C).

Tabel 3. Fluorgehalte van bladstukken van drie gladiolerasen vóór en na verblijf in gefluorideerd en niet-gefluorideerd water.

The injured lengths of the upper 10 cm of the 6th, 7th and 8th leaves (top three leaves) of both lots were then measured. The average figures for the treatments with fluoridated and non-fluoridated water were 36 mm and 12 mm, respectively.

The injuries to the leaves of the other varieties were measured after 9 days, when flowering had almost finished. The average length of the injured area of the variety 'Oscar' in fluoridated water was 25 mm and in non-fluoridated water 12 mm. The corresponding figures for the variety 'Mary Housley' were 29 and 14 mm.

In all varieties, besides injury to the leaf tips, isolated or partly isolated patches of injured tissue occurred on the leaf blades adjacent to the abnormal tips (Fig. 3). The above mentioned figures for injury indicate the total length of injured leaf tissue as if the totally and partly isolated patches were moved upwards to fit together with the injured tip.

A fluorine analysis of the leaves of nine flowering control plants was made before the experiment started and the fluorine concentration of the top 10 cm of the three youngest leaves of all three varieties was determined at the end of the experiment. The results are given in Table 3.

Discussion

American investigations indicate that uptake of fluorine from the soil does not cause plant injury as easily as does uptake of HF through the leaves. Roots of plants grown in a water culture supplied with soluble fluoride had a higher concentration than the aerial parts and were apparently able to retain fluoride (Daines et al., 1952; Thomas and Hendricks, 1956).

When the roots are cut off, so that this barrier for the fluoride translocation is eliminated, the aerial parts of the plants often contained a higher concentration. This accords with the experience of Jacobson et al., (1966) that fluoride remains soluble in plant leaves.

Parts of leaves or cut flowers placed with their bases in fluoridated water can take up this water freely through the cut surfaces, the water is then transpired from the leaf surfaces and the fluoride is retained. The fluoride accumulates in the leaves and may reach a concentration that is toxic for the tissue.

Non-fluoridated drinking water still contains a natural quantity of fluorine. This explains the difference in fluorine content of the leaf samples taken before and after a stay in non-fluoridated water (see Table 3).

Samenvatting

Beschadiging van gladiole-snijbloemen door gefluorideerd water

Aanzienlijk meer bladtopbeschadiging werd geconstateerd bij het voor HF zeer gevoelige gladioleras 'Sneeuwprinses' wanneer bladstukken met de basis in gefluorideerd leidingwater zijn geplaatst dan wanneer deze in niet gefluorideerd leidingwater staan. Ook werden bij de als snijbloem gebruikte gladiolerasen 'Sneeuwprinses', 'Oscar' en 'Mary Housley' de bladtoppen en de toppen van de schutblaadjes van de bloemen, door opname van gefluorideerd water meer beschadigd dan wanneer niet-gefluorideerd water werd toegepast.

Zowel de bladstukken als de bladeren van de bloemstengels bevatten in de 4 cm lange bladtoppen een aanzienlijk hoger fluorgehalte wanneer deze gefluorideerd water hebben opgenomen dan wanneer niet gefluorideerd water opgenomen werd.

References

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