CHLOROPHYLL FLUORESCENCE: A NEW TECHNIQUE TO SCREEN FOR TOLERANCE OF STRAWBERRY FLOWERS TO SPRING FROST

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Most strawberry cultivars have flowers which are sensitive to temperatures below 0°C. The development of early or very early cultivars with frost resistant flowers is a must in climates with a danger of spring frosts. Traditionally, breeding programs have used visual screening methods to evaluate the damage to pistils and anthers caused by frost. This method relies on natural seasonal conditions, is time consuming and does not provide accurate information on the exact temperature that caused the damage. Chlorophyll fluorescence (CF) is a technique which can be used to determine frost susceptibility of strawberry flowers. The flowers and leaves of selected strawberry cultivars were exposed to low temperatures and were subjected to CF analysis and also evaluated visually for damage. A positive correlation was found between the CF results and the degree of frost damage. CF is presently being evaluated in our breeding program for selecting early and very early strawberry selections with a high degree of frost tolerance.

Introduction:

Early spring low temperature is a limiting factor especially for very early or early cultivars. Most of the strawberry cultivars are sensitive to temperatures below 0°C and development of early or very early cultivars is necessary especially in a climate that has frequent danger of spring frost. The development of early cultivars requires screening for "resistant to spring frost" due to the susceptibility of most early strawberry cultivars to frost damage. The traditional method of selection for chilling-tolerant cultivars is time consuming and difficult and depends on the occurrence of frost in early spring. Chlorophyll fluorescence (CF) has been used to study the responses of plant tissue to various kinds of stress, including chilling/freezing tolerance. The level of variable fluorescence (Fv) is influenced by temperature, as chilling leads to a significant decrease in Fv. The objectives of this study were: 1) to determine if there is a relationship between CF and visual assessments of chilling damage, and 2) to test whether CF measurements could provide a rapid and simple method for selecting genotypes which are resistant to frost.

Materials & Methods

Sixty-four strawberry cultivars with variable degrees of chilling tolerance were analyzed. A completely randomized design with four replicates was used. Flowers from each replicate were exposed to 25° C for 24 h, to 0°C for 24 h, to -1°C for 24 h, to -2°C for 24 h and finally to -3°C for 24 h. Fv was measured following these temperature treatments.

Results

Generally Fv readings decreased with decreasing temperatures. This decrease was either not significant (frost tolerant), quadratic (frost tolerant to susceptible), or linear (susceptible), depending on the cultivar. This trend indicates that the flowers of most strawberry cultivars, except those which showed a non-significant (NS) effect, are vulnerable at -3°C (Table 1). Bogota, Bounty, Chandler, Honeoye, Idil, Korona, Lateglow, Stoplight and Tago showed no visual flower damage (VFD) at low temperatures and no significant decrease in Fv (Table 1). In addition, some Canoga, Chambly, and Cheam showed no VFD at low temperatures but their Fv decrease indicate that these cultivars may not be resistant to spring frost.

Cornwallis, Cruz, Darrow, Guardian, Oka, Redcoat, Tenira, and Veeglow showed no decrease in Fv values but some VFD was obse

they should be planted only in frost-free areas.

One should keep in mind that not only the drop in temperature but also the duration of low temperatures is an important factor, which affects VFD. The flowers of some cultivars that are resistant to short period frosts showed visual damage when exposed to the same low temperatures at longer periods.

The CF method is still under evaluation, modification and improvement at our station, but it appears to be a promising tool for selecting chilling tolerant genotypes.

Relationship between % visual flower damage and chlorophyll fluorescence measurement

Cultivar	Slop	Effect	FD
Addie	-0.7	Q	100.0
Annapolis	2.1	L	25.0
Apollo	-0.6	Q	94.0
Bernard	-0.6	Q	
Blomidon	-0.7	Q	0.0
Bogota	NS	NS	0.0
Bounty	NS	NS	0.0
Canoga	-0.6	Q	0.0
Cardinal	6.0	L	
Chambly	2.9	L	0.0
Chandler	NS	NS	0.0
Cheam	6.6	L	0.0
Cornwallis	NS	NS	60.0
Cruz	NS	NS	66.0
Darrow	NS	NS	22.0
Dunlap	-1.9	Q	25.0
Earliglow	-0.7	Q	64.0
Douglas	-0.7	Q	60.0
Dutch	-0.6	Q	66.0
Earliberle	-1.0	Q	
Elkhro	-1.0	Q	67.0
Fenella	-1.2	Q	
Gilbert	-0.6	Q	20.0
Glooscap	-1.0	Q	60.0
Grenadier	6.0	L	60.0
Guardian	NS	NS	72.0
Hapil	-0.6	Q	25.0
Heidar	2.1	L	22.0
Honeoye	NS	NS	0.0
Idil	NS	NS	0.0
Jewel	-0.7	Q	66.0
Kabelle	2.0	L	76.0
Kent	6.7	L	
Korona	NS	NS	0.0
Lateglow	NS	NS	0.0
Leader	-1.0	Q	20.0
Micmac	6.1	L	60.0
Midway	0.7	L	100.0
Minsk	1.6	L	
Oka	NS	NS	12.0
Primella	-0.7	Q	60.0
Protem	-0.9	Q	
Rantan	-0.9	Q	25.0
Redchief	-1.2	Q	60.0
Redcoat	NS	NS	16.0
Regina	-0.7	Q	60.0
Robinson	-0.6	Q	60.0
Sable	NS	NS	
Sparkle	-0.7	Q	44.0
Splendida	-0.7	Q	100.0
Stoplight	NS	NS	
0.0			
St-Clair	-1.2	Q	
St-Williams	NS	NS	
Sunrise	2.2	L	100.0
Tago	NS	NS	
0.0			
Tenira	NS	NS	16.0
Toro	6.4	L	44.0
Tyee	2.0	L	20.0
Vanlage	-0.6	Q	40.0
Veegem	6.6	L	77.0
Veeglow	NS	NS	20.0
Veestar	NS	NS	
Vibrant	2.3	L	
Zephir	2.1	L	60.0

Legend: Le Linear, Qe Quadratic, ns=Not significant, FD=% Flower damage

Additional Information on Agriculture and Agri-Food Canada, Quebec fruit breeding and physiology program can be obtained from http://www.pgris.com or contact the author SK (Khanizadehs@em.agr.ca)

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