Winterhardiness in Strawberries for the Pacific Northwest[1]

Hugh A. Daubeny, R. A. Norton[2], C. D. Schwartze[3], and Bruce H. Barritt[3]

Canada Department of Agriculture
Research Station, Agassiz, B. C.

Abstract. **Winter injury is the greatest limiting factor in strawberry production in southwestern British Columbia and northwestern Washington. In recent years the problem has been accentuated by the susceptibility of the widely grown cultivar 'Northwest' to injury. During the winter of 1968-1969, conditions were such that severe injury occurred in strawberry plantings throughout the region. It was possible, therefore, to assess the relative winter hardiness of various cultivars and advanced selections, from the strawberry breeding programs in British Columbia, Washington and Oregon, which had been placed at 5 locations in 1968. All the cultivars or selections were more winter hardy than Northwest and several appeared to have an outstanding level of hardiness. Some of the more hardy selections have as good processing quality as Northwest and at least one is likely to replace it within the next few years.**

Winter injury is the greatest limiting factor in strawberry production in southwestern British Columbia and northwestern Washington. Furthermore, it is apparent that the problem has been accentuated in recent years by the susceptibility of the cultivar 'Northwest' to injury. This cultivar, which has replaced more hardy ones because of its superior qualities for processing as a frozen product, now occupies approximately 90% of the 3,000 acres planted to strawberries in the region. In 2 recent years, 1965 and 1969, the potential yield of strawberries was reduced by at least 75% because of winter injury. In other years since 1960 yield reductions as high as 25% have been attributed to winter injury. Mulching is not practiced as in other regions because of the high autumn and winter rainfalls and the associated occurrence of crown diseases. Two sets of conditions appear to give rise to winter injury. The most severe type of injury, which causes the large yield losses, occurs from temperatures as low as -10F with little or no snow cover and frequent high winds. The second type of injury occurs after relatively warm temperatures, in which growth is initiated, followed by cooler temperatures which might range from 15F to 25F for varying lengths of time. The 'Northwest' cultivar is particularly susceptible to injury from both conditions.

During the winter of 1968-1969, conditions were such that severe injury occurred in strawberry plantings throughout the region. It was possible, therefore, to assess the relative winter hardiness of various cultivars and advanced selections, from strawberry breeding programs in British Columbia, Washington and Oregon, which had been placed on trial at 5 locations in 1968.

The locations of 4 trials in Washington and the cultivars and selections included in each are given in Table 1. At Everson the plots were 20 ft in length and at Lynden, 200 ft. There was approximately 1½ acres of each cultivar planted in the Sumas-1 trial and ½ acre of each in the Sumas-2 trial. In the fifth trial, located near Abbotsford, British Columbia, each of the 36 cultivars or selections was planted in a 25 ft plot in each of 3 randomized blocks. Plants in each trial formed matted rows approximately 14 inches in width.

Table 1. Winter hardiness, expressed as mean percent survival, of strawberry cultivars and selections in Washington trials.

Cultivar or selection	Mean % survival [1]			
	Trial			
	Everson	Lynden	Sumas-1	Sumas-2
Northwest	2	5	20	43
Marshall	33			
Puget Beauty	28			
Hood	27		30	
Nisqually	17			
Quinault	28			
Cheam	75	68	57	95
BC 1[2]	36			
BC 2	52			
BC 4	62			
BC 5	53			
WSU[3] 1165	63	40		
WSU 1169	43			
WSU 1217	20	30		
WSU 1224	10	35		
WSU 1232	37	20		
WSU 1239	78	60		
WSU 1019	67			
WSU 1173	57			
WSU 1172	50			
WSU 1227	40	25		
Ore-US[4] 2785	40			
Ore-US 2786	58			
Ore-US 2882	33			
Ore-US 2931	40			
Ore-US 2953	38			
Ore-US 2975	48			
Ore-US 2990	32			
Ore-US 2992	46			

[1] 100 indicates no apparent winter injury, 0 indicates death of all plants.

[2] BC selections are from the Canada Department of Agriculture strawberry breeding program at Agassiz, British Columbia.

[3] WSU selections are from the Washington State University strawberry breeding program at Puyallup, Washington.

[4] Ore-US selections are from the Oregon State University -- United States Department of Agriculture cooperative strawberry breeding program at Corvallis, Oregon.

[1] Received for publication December 22, 1969.

[2] Northwestern Washington Research and Extension Unit, Mt. Vernon.

[3] Western Washington Research and Extension Center, Puyallup.

In the spring of 1969 winter injury of plots in each trial was determined by a subjective score ranging from 10 for no apparent injury to 0 for complete death of all plants in the plot.

On April 15, the Everson and Sumas-1 plots were examined by 3 independent observers and those at the other 2 Washington trials by 2 independent observers. The ratings of the different observers usually did not disagree by more than 1 or 2 score points in the 0 to 10 range. The mean rating, expressed as a percent for each cultivar or selection, is given in Table 1. The plots near Abbotsford were examined by 1 observer on 4 dates, approximately 10 days apart, beginning on March 10. The mean rating obtained from these dates for each cultivar or selection is given in Table 2 as a percent of the highest score possible. Yield data obtained from these are given in Table 3.

In the Washington trials, plants of 'Cheam' and 'WSU 1239' showed the most winter hardiness and those of 'Northwest' the least (Table 1). The relatively high scores for the cultivars in the Sumas-2 trial was most likely due to the proximity of a windbreak. The relatively low score for 'Cheam' in the Sumas-1 trial was most likely a reflection on poor runner plant production the previous summer rather than winter injury. Although yield data were not obtained from any of the Washington trials, it was observed that even the plots which showed relatively good survival produced less fruit with greater amounts of malformation than is normal. This suggests varying degrees of flower bud damage.

In the Abbotsford trial, plants of 'BC 15', 'Ore-US 2975', 'Cheam' and 'BC 25' showed the most winter hardiness and those of 'Northwest' the least (Table 2). The highest yielder was 'BC 25' and 'Northwest' was among the lowest (Table 3). There was a highly significant correlation (r = .45, df = 107) between plant survival and yield. However, the survival of certain cultivars or selections did not reflect their yield. For example 'BC 26' showed excellent plant survival but was among the lowest yielders. In contrast, 'BC 18' showed relatively poor survival but was among the highest yielders. Such relationships suggest that plant and flower bud hardiness are not necessarily the same.

Table 2. Winter hardiness, expressed as mean percent survival, of strawberry cultivars and selections in the Abbotsford, British Columbia trial.

Cultivar	Winterhardiness[1]	
BC 15	81.7	a
Ore-US 2975	73.3	ab
Cheam	73.3	ab
BC 25	70.0	abc
BC 11	69.2	bcd
BC 4	69.2	bcd
Ore-US 2931	69.2	bcd
BC 9	68.3	bcde
BC 26	65.8	bcdef
Siletz	64.2	bcdefg
BC 64-55-39	64.2	bcdefg
BC 64-52-55	60.0	bcdefgh
BC 14	60.0	bcdefgh
BC 64-28-41	60.0	bcdefgh
BC 21	59.2	bcdefgh
BC 64-29-18	59.2	bcdefgh
BC 64-28-39	57.5	cdefghi
BC 12	55.8	cdefghij
BC 64-28-24	55.0	cdefghijk
BC 28	55.0	cdefghijk
BC 17	54.2	defghijk
Ore-US 2992	54.2	defghijk
BC 5	54.2	defghijk
Puget Beauty	54.2	defghijk
BC 18	54.2	defghijk
Ore-US 2990	53.3	efghijk
Agassiz	52.5	fghijk
BC 65-19-40	50.0	ghijk
BC 64-22-18	50.0	ghijk
BC 64-19-46	48.3	hijk
BC 64-28-29	47.5	hijk
BC 16	45.8	hijk
Hood	45.0	hijk
BC 64-55-37	43.3	ijk
BC 19	40.8	jk
Northwest	40.0	k

[1]The arc sin transformation was used for analysis of the mean percent survival scores. The percents followed by the same letter are not significantly different at the 5% level.

Table 3. Yield of strawberry cultivars and selections in the Abbotsford, British Columbia trial.

Cultivar	Yield expressed as lb. per plot[1]	
BC 25	23.59	a
BC 15	21.00	ab
BC 14	17.92	abc
Cheam	17.81	abc
BC 18	17.44	abcd
BC 28	16.71	abcde
Agassiz	16.03	abcdef
BC 64-28-41	14.68	abcdefg
BC 16	14.43	bcdefgh
BC 11	14.33	bcdefgh
Ore-US 2931	13.00	bcdefghi
Siletz	12.81	bcdefghi
BC 4	12.42	bcdefghi
BC 21	12.33	bcdefghi
BC 17	12.02	bcdefghi
Ore-US 2975	11.77	cdefghi
BC 64-29-18	11.52	cdefghi
BC 64-28-29	10.98	cdefghi
BC 64-28-39	10.94	cdefghi
BC 64-55-39	10.94	cdefghi
BC 12	10.42	cdefghi
BC 65-19-46	10.35	cdefghi
BC 9	9.77	cdefghi
BC 64-55-37	9.21	cdefghi
BC 64-52-55	8.71	cdefghi
Northwest	8.38	defghi
Ore-US 2990	7.98	efghi
Ore-US 2992	7.97	efghi
BC 64-28-24	7.96	efghi
BC 5	6.88	fghi
Puget Beauty	6.62	ghi
Hood	5.77	ghi
BC 64-22-18	5.33	hi
BC 26	5.21	hi
BC 65-19-40	4.58	i
BC 19	4.35	i

[1]Those means followed by the same letter are not significantly different at the 5% level.

It is of interest that transgressive segregation for winter hardiness might be of relatively frequent occurrence in strawberry breeding. Both 'Cheam' ('Siletz' x 'Puget Beauty') and 'WSU 1239' ('WSU 685' ('Sierra' x 'Northwest') x 'Columbia') are considerably more hardy than their respective parents. Some other examples of selections which probably show greater winter hardiness than their respective parents are 'WSU 1165' ('Northwest' x 'Columbia'), 'WSU 1172' and 'WSU 1173' (both 'Cascade' x 'Puget Beauty'), 'BC 2' ('Siletz' x 'Puget Beauty'), 'BC 5' ('Northwest' x 'Puget Beauty'), 'BC 15' ('Northwest' x 'BC 59-22-35' ('Siletz' x 'Puget Beauty')) and 'BC 25' ('BC 59-22-35' x 'Northwest').

From the data presented it is obvious that strawberry breeding programs in British Columbia, Washington and Oregon are producing cultivars or selections that are more winter hardy than 'Northwest'. It is encouraging that several of these have as good processing quality as 'Northwest'. It is reasonable to assume that at least one will replace Northwest' within the next few years and thus help to stabilize strawberry production throughout the region.