Winter frost resistance of grapevine varieties belonging to different ecological and geographical groups

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Summary: The influence of frost temperatures on survival of the buds was investigated *in situ* during 3 winters. The behavior of 375 grapevine varieties belonging to different ecological-geographical groups was studied at 3 locations.

The rate of buds killed by frost ranged from 5.4 to 100 %. The varieties of the group convar. *occidentalis* exhibited the greatest frost resistance of buds during 3 winters with very low temperatures. In this group the percentage of killed buds was significantly lower than in the group convar. *pontica* and much less than in the group convar. *orientalis*.

Key words: cold resistance, winter frost, bud, variety of vine, convarietas, location, year, climate, Yugoslavia.

Introduction

Many factors influence the resistance to low winter temperatures which has been shown by many authors (Lazic and Zorzic 1956; Kondo 1959; Pogosian 1967; Nagru 1971; Ratkovic 1979; Turmanidze 1981; Cindric 1984; Avramov and Zunic 1986; Avramov *et al.* 1987; Milosavljevic *et al.* 1987; Tadijanovic *et al.* 1988, and others).

Starting from the existing knowledge about the resistance of grapevine to low winter temperatures, we report the results from an *in situ* investigation on the response of different grapevine varieties to low temperatures during the period from 1984 to 1987 in the areas where ampelographic collections are located.

Materials and methods

The investigations were performed at 3 locations with existing ampelographic collections. The number of varieties was different in each collection. At 'Radmilovatz', 'Svetozarevo' and 'Bela Crkva' 286, 73 and 34 varieties, respectively, were investigated.

The age of the plants was different. The number of developing and non-developing buds was checked *in situ* after winters with extremely low temperatures.

Analysis of variance was utilized to determine significant differences between the percentages of killed buds in the same varietal group as well as between the different varietal groups taking into consideration the year and location.

Also checked was the significance of correlations between the temperature limits (0, -10, -15, -20 and -25 °C) and the degree of killed buds for each of the different groups of varieties. The dependency is presented by linear regression.

During the 3 years of our investigation, extreme air temperatures were recorded daily from October to April. We also must note that during the winter 1986/87 at the location 'Svetozarevo' an extraordinarily low temperature (-32 °C) was recorded for several hours.

Results and discussion

For clarity the results are presented graphically (Figs. 1, 2 and 3). We analyzed and presented examples only for 5 varieties which are considered models for their ecological-geographical groups (Tables 1, 2 and 3).

a) Group convarietas *orientalis*

The varieties of this group – Dattier of Beyrouth, Red Adacalca, Chirey Bayan, Hindogni and Tavriz – at all 3 locations during the 3 years of the investigation had very high average percentages of killed buds. The results of investigations are summarized in Table 1; the data show:

– During the winter 1986/1987 in all varieties of this group the highest percentages of killed buds were determined at all 3 locations.

– Statistically significant differences between the varieties of this group for the 3 years at individual locations were not determined.

– At the different locations in the same year, the same varieties exhibited significant differences in the percentages of killed buds. This can be explained by the different low temperature extremes and different times of exposure to these temperatures.

Behavior similar to that of the chosen examples was observed with the other varieties of this ecological-geographical group (Fig. 1).

b) Group convarietas *pontica*

The varieties of this group – Bagrina, Plovdina, Prokupatz, Skadarka and Vranatz – exhibited a middle-high average percentage of killed buds. The results of investigations are summarized in Table 2; they show:

– The lowest average percentages of killed buds were determined at 'Radmilovatz' in 1985/1986 and at 'Bela Crkva'in 1984/1985.

– In the varieties of this group at the same locations and years of investigations, significant differences were determined. The variety Vranatz exhibited a significantly higher percentage of killed buds than the other varieties of this group.

– Between the locations and the years of the investigations statistical differences were apparent by analysing the percentage of killed buds.

– All buds in this group of varieties were completely killed during the winter 1986/1987 at the location 'Svetozarevo'.

– At all locations the varieties exhibited the highest percentage of killed buds during the winter 1986/1987.

– Comparing the varieties of the group convar. *orientalis* with the varieties of the group convar. *pontica*, the latter were found to have few killed buds after winters with extremely low temperatures at almost every location investigated. From the varieties of the group convar. *pontica*, only Vranatz is similar to the varieties of the group convar. *orientalis*.

Behavior similar to that of the chosen examples was observed with the other varieties of this ecological-geographical group (Fig. 2).

c) Group convarietas *occidentalis*

The varieties of this group – Cabernet Sauvignon, Cabernet franc, Pinot noir, White Riesling and Italian Riesling – exhibited the lowest average percentage of killed buds taking into consideration the locations and years investigated, compared with the varieties of the groups convar. *orientalis* and convar. *pontica*. The results of the investigations which are summarized in Table 3 show the following:

– In the varieties of the group convar. *occidentalis* the percentage of killed buds was from 5.4 % (Cabernet Sauvignon) to 32.1 % (Italian Riesling).

Table 1: The influence of low winter temperatures on the average percentages of killed buds in varieties of convarietas *orientalis*

Location/Year	V a r i e t i e s				
	Dattier of Beyrouth %	Red Adacalca %	Shirey Bayan %	Hindogni %	Tavriz %
1.Location:"Radmilovatz"					
1984/1985	37,94	26,74	26,22	22,65	23,78
1985/1986	62,o5	65,18	64,9o	64,o2	68,97
1986/1987	9o,38	89,83	96,o6	87,78	88,o7
2.Location:"Svetozarevo"					
1984/1985	61,66	48,32	59,7o	56,4o	52,oo
1985/1986	24,3o	25,13	48,3o	32,o8	3o,4o
1986/1987	loo,oo	loo,oo	loo,oo	loo,oo	loo,oo
3.Location:"Bela Crkva"					
1984/1985	62,36	56,o2	61,o2	6o,o8	68,9o
1985/1986	--	--	--	--	--
1986/1987	82,4o	8o,3o	76,4o	69,4o	65,4o

$LSD_{o,ol}$

$LSD_{o,o5}$

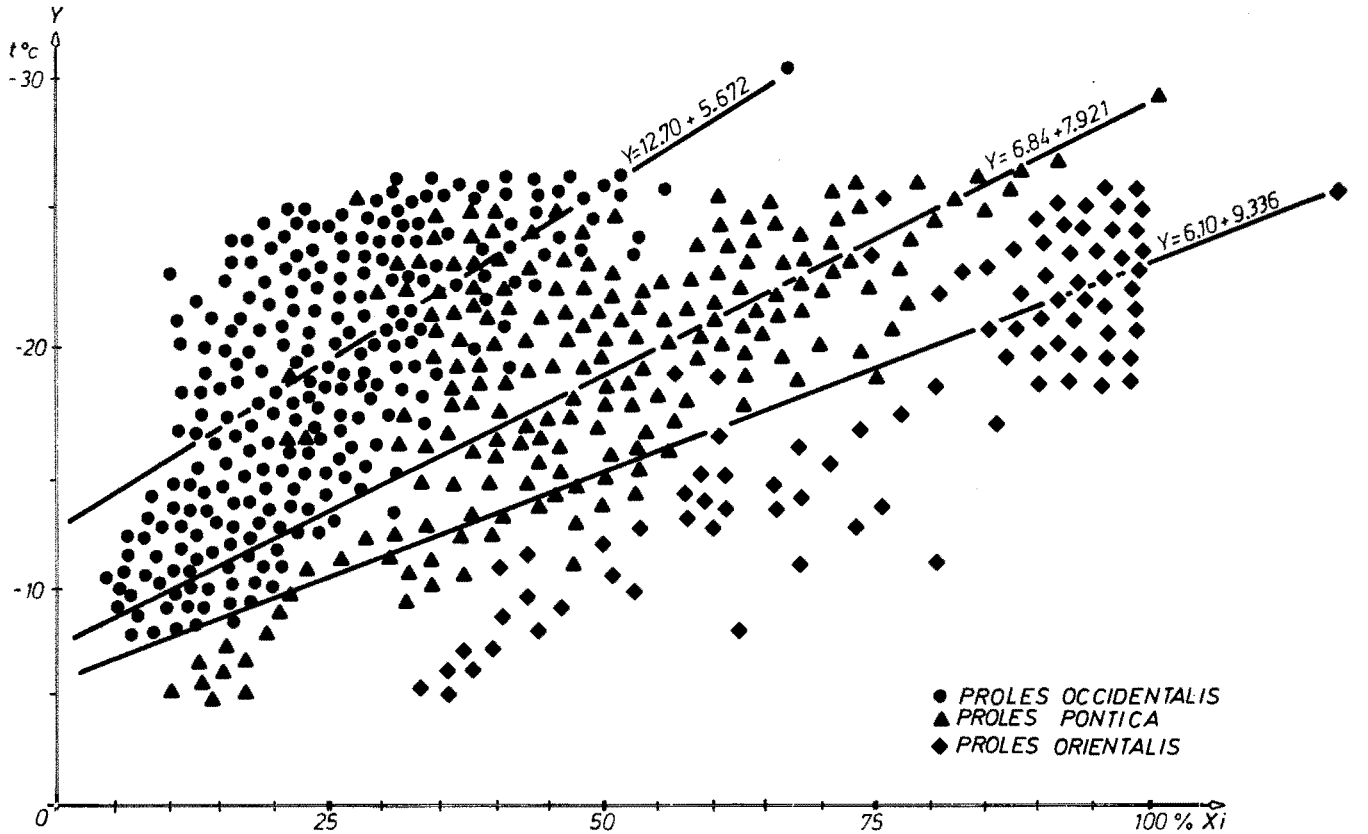

Fig. 1: Percentages of killed buds dependent on low winter temperatures in varieties belonging to different ecological-geographical groups. Location 'Radmilovatz'.

Table 2: The influence of low winter temperatures on the average percentages of killed buds in varieties of convarietas *pontica*

Location/Year	V a r i e t i e s				
	Bagrina %	Plovdina %	Prokupatz %	Skadarka %	Vranatz %
1.Location:"Radmilovatz"					
1984/1985	26,63	46,15	3o,91	31,48	58,77 ++
1985/1986	42,6o	46,12 +	38,32	31,6o	64,88 ++
1986/1987	84,44	93,51	82,14	78,55	96,41 ++
2.Location:"Svetozarevo"					
1984/1985	36,25	42,o1	38,3o	32,6o	46,42 ++
1985/1986	28,42	36,2o +	36,2o +	30,o8	49,6o ++
1986/1987	loo,oo	loo,oo	loo,oo	loo,oo	loo,oo
3.Location:"Bela Crkva"					
1984/1985	38,42	4o,2o	5o,oo	46,13	58,4o ++
1985/1986	--	--	--	--	--
1986/1987	64,o6	66,3o	61,9o	68,4o	74,o9 ++

$LSD_{o,o1}$

$LSD_{o,o5}$

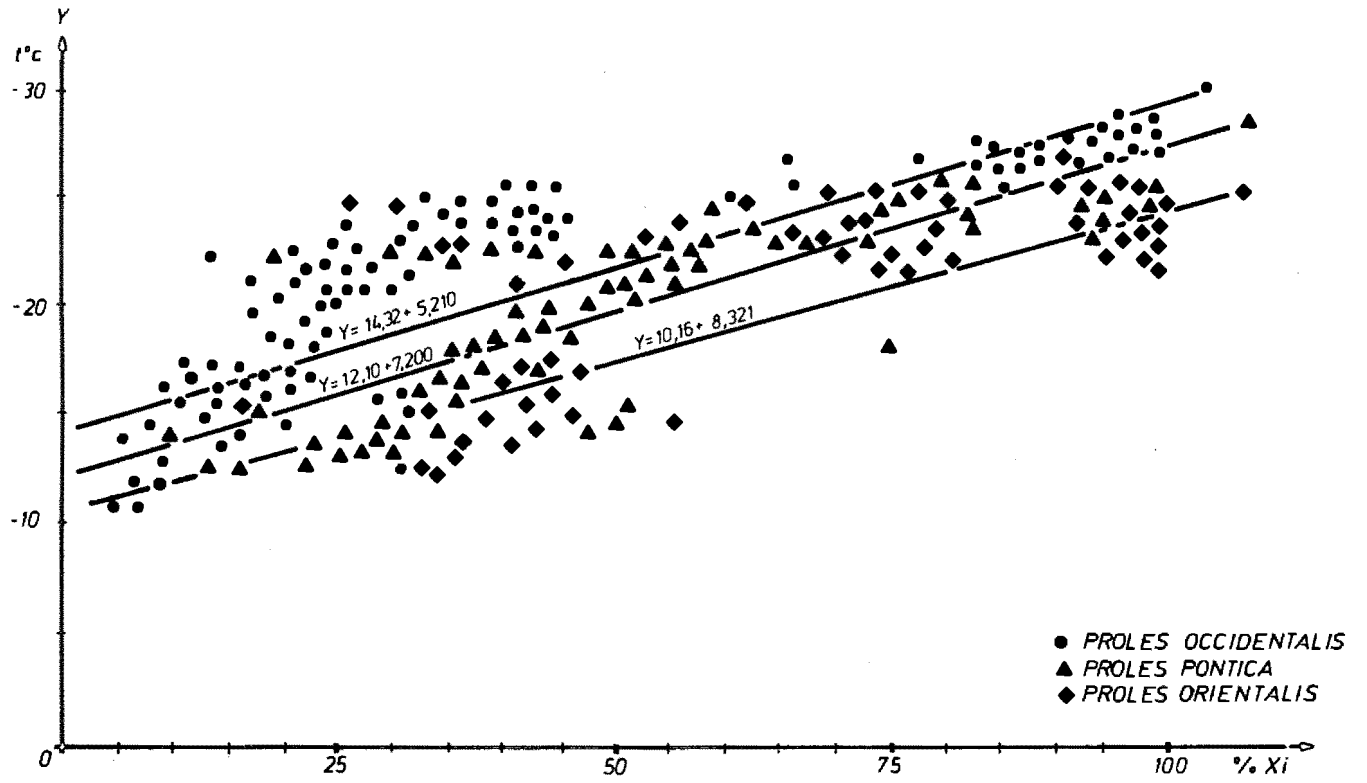

Fig. 2: Percentages of killed buds dependent on low winter temperatures in varieties belonging to different ecological-geographical groups. Location 'Svetozarevo'.

Table 3: The influence of low winter temperatures on the average percentages of killed buds in varieties of convarietas *occidentalis*

Location/Year	V a r i e t i e s				
	Cabernet sauvignon %	Cabernet franc %	Pinot noir %	White Riesling %	Italien Riesling %
1.Location:"Radmilovatz"					
1984/1985	12,29	11,oo	11,26	14,59	11,o7
1985/1986	1o,o8	6,89	11,26	15,24	19,87
1986/1987	5,41	1o,6o	15,9o	15,5o	28,3o
2.Location:"Svetozarevo"					
1984/1985	14,32	16,o8	16,99	2o,oo	24,2o ++
1985/1986	6,3o	8,5o	1o,2o	11,6o	15,3o
1986/1987	1oo,oo	1oo,oo	1oo,oo	1oo,oo	1oo,oo
3.Location:"Bela Crkva"					
1984/1985	12,45	18,o2	14,82	2o,6o	3o,6o ++
1985/1986	--	--	--	--	--
1986/1987	15,66	21,65	2o,oo	2o,86	32,13 ++

$LSD_{0,01}$

$LSD_{0,05}$

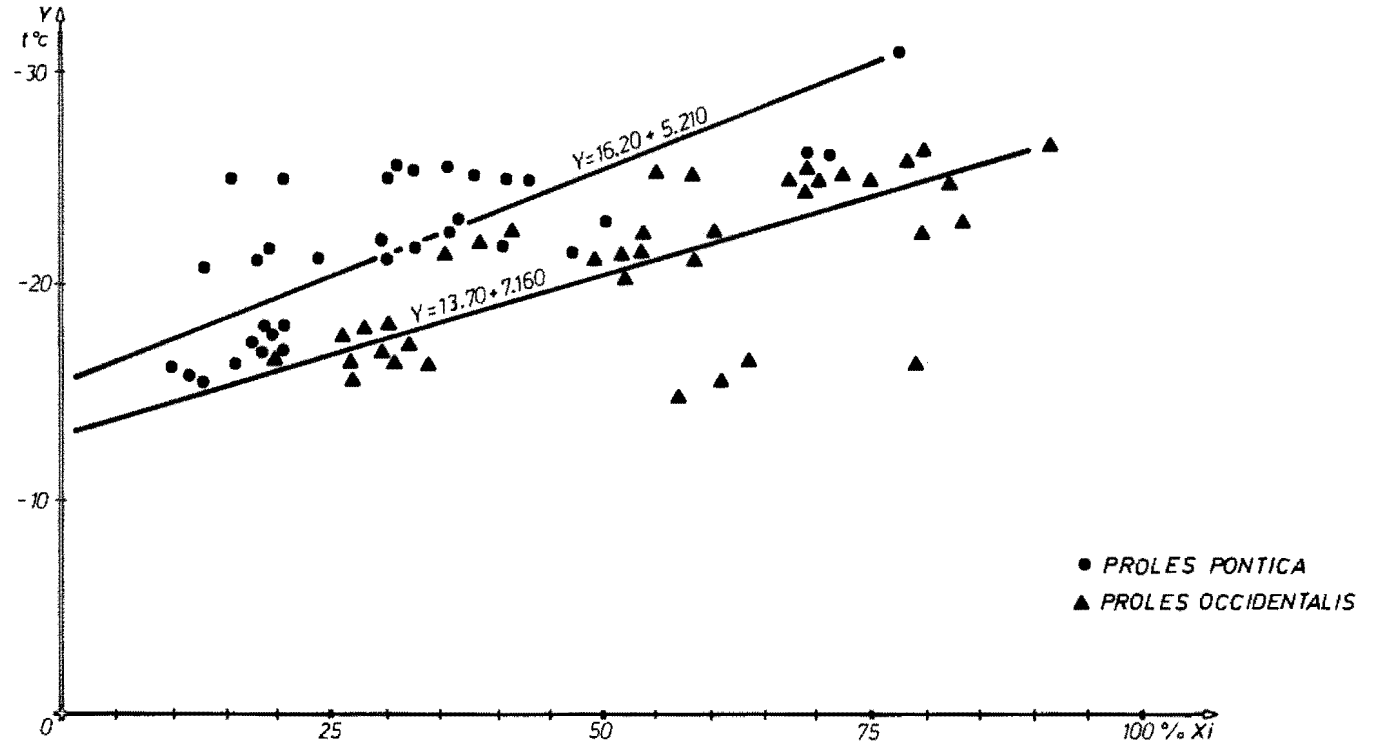

Fig. 3: Percentages of killed buds dependent on low winter temperatures in varieties belonging to different ecological-geographical groups. Location 'Bela Ckrva'.

- All buds in the varieties of this group were killed during the winter 1986/1987 at 'Svetozarevo'.

- Significant differences between the percentages of killed buds in this group were not determined comparing individual locations in the same years of investigation and comparing the years at the same locations.

- Significant differences were apparent between different varieties. The variety Italian Riesling exhibited in all investigated years at the same locations significant and much higher percentages of killed buds compared with the varieties Cabernet Sauvignon, Cabernet franc, Pinot noir and White Riesling.

Behavior similar to that of the chosen examples was observed with the other varieties of this ecological-geographical group (Fig. 3).

Otherwise, our investigations show that the *Vitis vinifera* varieties exhibit different resistances to low winter temperatures depending on their origin. The most resistant varieties belong to the group convar. *occidentalis*, and most sensitive are the varieties of the group convar. *orientalis*. The varieties which are by origin from the same ecological-geographical group also exhibit different resistance to winter temperatures.

The frost resistance of buds of grapevine varieties is also conditioned by pruning severity (Cindric and Briza 1982), trunk height (Jurcevic and Nakalamic 1969; Milosavljevic and Nakalamic 1969), position on the cane (Avramov *et al.* 1987) and the water status of the organs during winter (Cindric 1975; Tadijanovic *et al.* 1988). Other significant factors include the length of exposure of grapevine to low temperatures and the character of the low temperatures (snow, ice, wind).

The genetically conditioned resistance to low temperatures also depends on the method of fertilization (nutrition) just before winters with extremely low temperatures (Milosavljevic *et al.* 1987).

Conclusions

Taking into consideration our investigations and published data about the percentage of killed buds of the varieties belonging to different ecological-geographical groups during winters with extremely low temperatures, we can conclude:

1. The temperature conditions during the years of the investigations at all 3 locations with ampelographic collections resulted in significant percentages of killed buds. Extremely low winter temperatures were apparent during 1986/1987 when -25 °C was the usual daily low temperature and at 'Svetozarevo' -32 °C was observed during a short interval.

2. The varieties of the ecological-geographical group convar. *occidentalis* exhibited the greatest bud frost resistance during 3 winters with very low temperatures, which was significantly lower than the percentage of killed buds of the varieties of group convar. *pontica* and much less than the percentage of killed buds of the varieties of group convar. *orientalis*.

3. At location 'Svetozarevo' during the winter 1986/1987 all buds were completely killed.

4. The investigated varieties exhibited the highest percentage of killed buds during the winter 1986/1987 at all locations.

5. In conclusion we can say that the resistance of buds of a variety to low temperatures is conditioned by a complex of many factors. The ecological-geographical origin of the variety is also responsible for the resistance of the variety to low winter temperatures under our ecological conditions. This is also very important when choosing parents for the creation of new adapted varieties.

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