Winter frost resistance of Hayward and Matua kiwifruit cultivars

M. BURAK, H. SAMANCI, M. BÜYÜKYILMAZ

Atatürk Central Horticultural Research Institute, Yalova, Turkey

ABSTRACT: This study was carried out in Atatürk Central Horticultural Research Institute at Yalova in 1996 and 1997 in order to determine the frost resistance ability of fruit buds of Hayward and Matua cultivars by artificial freezing tests during winter months. Twig samples for artificial freezing tests were taken one week after defoliation, and at three-week intervals throughout the winter. The buds were exposed to temperatures of –10°C, –13°C and –15°C for 2, 4 and 6 hours. Then they were planted in a greenhouse for survival tests. It was found that –13°C and –15°C were very harmful temperatures for both cultivars even for the duration of 2 hours at -15^0C. On the other hand, both cultivars could resist to –10°C for the duration of 6 hours. In general, Hayward is more sensitive to frost than Matua. Both cultivars showed higher resistance in February. As a result, Hayward and Matua cultivars could be grown safely in areas with as low temperatures as –10°C in winter months.

Keywords: kiwifruit; frost resistance; freezing tests; Hayward; Matua

Kiwifruit is a new crop for Turkey. It has been introduced quite recently. The most important aspect of kiwifruit production is its ecological adaptation. Especially the low temperature is a crucial limiting factor. Turkey has quite different agro-ecological zones. To recommend kiwifruit growing in such areas the information about the resistance of fruit buds to low temperatures is necessary.

Studies on freezing injuries of kiwifruits are mostly based on field observations rather than on artificial freezing tests. However, due to kiwi dissemination throughout different parts of the world in recent years some studies have been carried out in controlled conditions. In Italy, after a frosty period in January 1985, COSTA et al. (1985) observed that injuries were small to –15°C, but injuries increased sharply at temperatures below –15°C and the plants were nearly totally damaged at –21°C. They also observed that Hayward was the most sensitive cultivar.

KAMOTA et al. (1989) studying 4 kiwifruit cultivars at 6 different localities found more than 50% injuries of the cultivars at –15°C and –18°C while the most resistant cultivar was Abbot, the most sensitive was Hayward.

On the other hand, CHANUKVADZE et al. (1990) indicated that Monthy cultivar did not show any injuries to –10°C in a dormant season, but one-year-old shoots were injured at –12°C and –13°C. In the same study, –16°C caused total injury and thus they claimed that kiwifruits should not be grown in areas with temperatures below –15°C in winter.

Many other authors found that *Actinidia deliciosa* is the most sensitive, whereas *A. arguta* and *A. kolomikta* are the most resistant species of Actinidia (BLANCHET 1992; CHAT, SCHMIDT 1994).

The aim of this study was to determine the winter frost resistance of commercially recommended kiwifruit cultivars Hayward and Matua.

MATERIAL AND METHODS

In this study the buds of 7 years old Hayward and Matua cultivars were examined. The buds were exposed to –10°C, –13°C and –15°C for the duration of 2, 4 and 6 hours, starting from December through March in 1995–1996 and 1996–1997. The controls were kept in a refrigerator for 12 hours.

In artificial freezing tests, 100 twigs per treatment were put in a freezer that was automatically controlled by a temperature-controller unit and then the temperature was lowered at the rate of 5°C per hour to the desirable low degrees (BURAK, ERIŞ 1990).

The twigs that completed the desired time under the test low temperature were taken from the unit and put into a refrigerator for 12 hours. Then they were planted as one-eye buds in wetted pearlite media in a glasshouse for bud survival tests. The bud survival was based on sprouting percentages.

The experiment was designed as randomised blocks with four replications and 25 buds per plot. Duncan's multiple range test was used in statistical analyses.

RESULTS

The daily minimum temperature of the experimental periods is shown in Fig. 1.

The bud survival percentages of the cultivars are shown in Tables 1 and 2. The differences between the cultivars and the treatments were statistically significant. In both experimental periods and in nearly all treatments Matua was found to be hardier than Hayward.

At –10°C in general, in all months more than 60% bud survival rates were obtained for 2, 4 and 6 hour durations in both cultivars (Table 1).

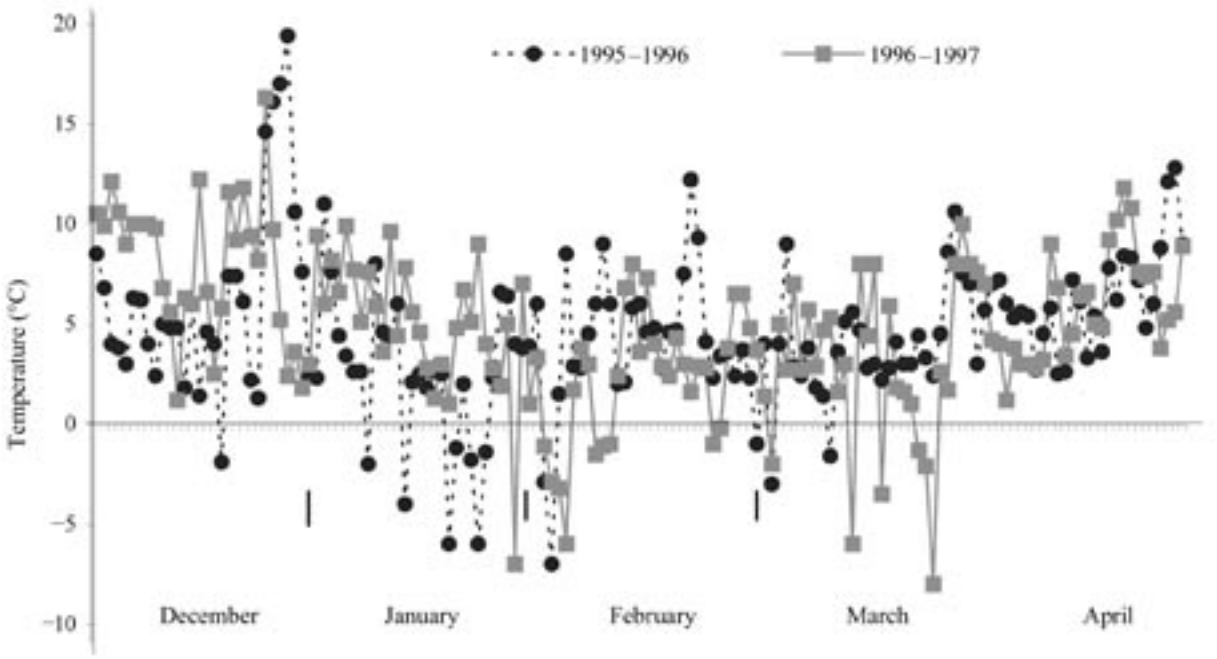

Fig. 1. Daily minimum temperatures during the experimental period (°C)

Table 1. The bud survival percentages of Hayward and Matua kiwifruit cultivars exposed to artificial freezing tests at –10°C, –13°C and –15°C (%) (1995–1996)

Cultivar	Months	–10C° Duration (hours)				–13°C Duration (hours)			–15°C Duration (hours)		
		0 con.	2	4	6	2	4	6	2	4	6
Hayward	December	95.0	85.0 a	73.7 a	65.0 a	69.0 a	25.0 b	5.0	41.0 b	39.0 a	7.0
	January	92.9	67.0 b	22.0 b	20.0 b	67.0 a	24.0 b	17.0	8.0 c	3.0 b	1.0
	February	93.0	79.0 ab	67.0 a	34.0 b	67.0 a	59.0 a	7.0	60.0 a	45.0 a	3.0
	March	93.0	52.0 c	18.0 b	13.0 c	15.0 b	2.0 c	4.0	3.0 c	3.0 b	0.0
		ns						ns			ns
Matua	December	100.	90.0 a	81.2 a	59.7 a	78.0 a	55.0 a	38.0 a	65.2 a	61.9 a	17.0 a
	January	95.6	50.0 c	40.0 b	26.2 b	52.5 b	48.7 a	23.7 b	15.0 c	3.7 c	1.2 b
	February	93.7	85.0 a	83.7 a	53.7 a	67.5 ab	50.6 a	25.0 b	58.0 a	37.5 b	11.0 a
	March	93.0	70.5 b	37.5 b	31.2 b	35.0 c	31.0 b	11.2 c	32.5 b	18.7 c	5.0 b
		ns									

Values in the same column followed by the same letter(s) do not differ significantly (mean separation by Duncan's multiple range test at 0.05 level); ns – not significant; con. – control (0 hour for freezing tests)

Table 2. The bud survival percentages of Hayward and Matua kiwifruit cultivars exposed to artificial freezing tests at –10°C, –13°C and –15°C (%) (1996–1997)

Cultivar	Months	–10°C Duration (hours)				–13°C Duration (hours)			–15° Duration (hours)		
		0 con.	2	4	6	2	4	6	2	4	6
Hayward	December	92.0	81.0 b	76.0 b	72.0 b	41.0 b	39.0 b	27.0 b	40.0 ab	16.0 c	6.0 c
	January	89.6	60.0 c	47.0 c	47.0 d	37.7	30.0 b	26.2 b	29.9 b	22.2 b	20.2 ab
	Beg. of Febr.	87.9	86.0 a	87.0 a	82.0 a	75.0 a	57.0 a	56.0 a	21.0 b	15.0 c	15.0 bc
	End of Febr.	96.0	67.0 c	55.0 c	55.0 c	66.0 a	58.0 a	48.0 a	33.0 b	34.0 a	31.0 a
	March	100.0	94.0 a	93.0 a	84.0 a	78.0 a	69.0 a	60.0 a	56.0 a	31.0 ab	15.0 b
		ns									
Matua	December	93.2	93.0	82.1 ab	78.9 a	47.0 c	47.2 c	42.0 b	25.4 b	15.0 bc	13.8 bc
	January	89.5	75.0 b	75.0 b	71.2 b	62.5 b	42.5 c	35.0 b	40.3 ab	21.2 bc	20.0 b
	Beg. of Febr.	98.7	93.7 a	91.2 a	85.0 a	90.0 a	86.2 a	81.0 a	41.9 ab	23.7 b	22.1 b
	End of Febr.	100.0	93.7 a	81.2 ab	82.8 a	83.7 a	82.5 a	78.7 a	62.5 a	53.7 a	48.7 a
	March	100.0	90.0 a	80.0 ab	82.5 a	76.2 b	62.5 b	62.5 a	55.0 ab	12.5 c	3.7 c
		ns									

At –13°C, both cultivars showed more than 50% bud survivals in 2 hours treatments, except in March 1996. In 4 hours treatment, Hayward showed 50% bud survivals in February 1996 and in February and March 1997 whereas Matua showed more than 50% bud survivals in both periods, except in March 1996. In 6 hours treatments both cultivars showed less than 50% bud survivals in nearly all periods.

At –15°C, both cultivars showed less than 50% bud survivals in both experimental periods in 2, 4 and 6 hour durations.

In general, Matua was found to be much hardier than Hayward. On the other hand, as the test durations increased, the bud injuries increased accordingly and thus the bud survival percentages decreased.

DISCUSSION

It seems that the occurrence of a low temperature of –10°C for the duration of 2, 4 and 6 hours will not be harmful for both cultivars. However, in January and March in the period 1995–1996 both cultivars showed less than 50% bud survivals. As can be seen in Fig. 1, this could be due to the outside high air temperature at that time of the experiment. Therefore it can be concluded that both cultivars could resist a low temperature of –10°C for the duration of 2, 4 and 6 hours.

In general, Hayward could resist to –13°C for 2 hours duration, Matua for 4 hours duration. So –13°C seems –15°C caused nearly total bud injury for both cultivars in both experimental periods in all treatments. Thus this temperature degree could be an extreme degree for both cultivars.

Matua was found to be much hardier than Hayward. This result is in agreement with those of TESTOLIN and MESSINA (1989). On the other hand, it was observed that the frost resistance ability of kiwifruit buds was affected importantly by the outside air temperature, as other deciduous fruits that were investigated by PROEBSTING and MILLS (1971), and BURAK et al. (1993).

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Odolnost proti zimním mrazům u odrůd kiwi Hayward a Matua

ABSTRAKT: Studium jsme uskutečnili v letech 1996 a 1997 v Atatürkově Ústředním výzkumném ústavu pro zahradnictví v Yalově s cílem stanovit pomocí testů na mrazuvzdornost aplikovaných během zimních měsíců citlivost květních pupenů na mráz u odrůd Hayward a Matua. Výhony pro testy na mrazuvzdornost jsme odebírali ve třítýdenních intervalech během zimního období, přičemž první odběr nastal vždy týden po opadu listů. Pupeny jsme vystavovali nízkým teplotám –10º C, –13º C a –15º C po dobu 2, 4 a 6 hodin. Potom jsme je vysadili do skleníku, kde jsme hodnotili jejich další růst (přežití). Zjistili jsme, že teploty –13º C a –15º C jsou pro obě odrůdy velmi škodlivé. V případě teploty –15º C dokonce docházelo k úhynu při působení mrazu po dobu pouhých dvou hodin. Naproti tomu obě odrůdy byly odolné vůči teplotě –10º C, aplikované po dobu šesti hodin. Obecně platí, že odrůda Hayward je na mráz citlivější než odrůda Matua. Obě odrůdy vykazovaly vyšší odolnost

v únoru. Z výsledků vyplývá, že se odrůdy Hayward a Matua mohou bezpečně pěstovat jen v oblastech, kde minimální teploty v zimních měsících neklesají pod –10º C.

Klíčová slova: kiwi; mrazuvzdornost; testy na mrazuvzdornost; odrůda Hayward; odrůda Matua

Corresponding author:

Assoc. Prof. Dr. MASUM BURAK, Atatürk Central Horticultural Research Institute, 77102 Yalova, Turkey
tel.: + 90 226 814 10 05, fax: + 90 226 814 11 46, e-mail: masumburak@hotmail.com