Blackspot bruising of processing potatoes during storage

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ABSTRACT

The change in blackspot bruise susceptibility of potatoes during storage at 12°C was investigated for about 4 months using potato chip processing cultivars (Norin-ichigo and Toyoshiro). Norin-ichigo and Toyoshiro potatoes had a high blackspot susceptibility at both initial storage and sprouting, with Norin-ichigo being more susceptible to blackspot than Toyoshiro. In addition, the stem end area of both potatoes was much more susceptible compared with the other areas (middle and bud end).

Key words : processing potatoes, storage, blackspot

INTRODUCTION

Discoloration of raw potatoes, an abnormal physiological condition which occurs when potatoes are bruised, is one of the most serious and costly problems in the potato industry (Mondy et al., 1960). Usually blackspot bruise evaluations are most often conducted at harvest in order to determine how harvesting and handling operations or cultural practices have influenced this disorder. However, susceptibility to blackspot when tubers are removed from storage, particularly if the potatoes are destined for the fresh produce market, should also be evaluated (Dean et al., 1993). Nevertheless, very few reports were found on blackspot bruising of potatoes during storage. While Schippers (1971) indicated that bruise susceptibility decreased slowly in storage, Boyd (1951) and Mondy et al. (1960) showed just the opposite. As a consequence, the propensity to bruise or discolor during storage has yet to be clearly quantified.

Norin-ichigo and Toyoshiro are very popular and important cultivars (Iwahune, 1993 ; Tokachi Nogyo Kyodo Kumiai Rengokai, 1993) for potato chips in Hokkaido, Japan. However, there was little information concerning changes in the blackspot susceptibility of their potatoes during storage. Thus, this study was conducted to investigate any such changes in these two cultivars.

MATERIALS AND METHODS

Samples and tuber storage

Toyoshiro and Norin-ichigo potatoes were harvested from the Kawanishi District, Obihiro, Hokkaido on Sep. 26, 1995, and Oct. 11, 1995, respectively. On harvest day, samples of both

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potatoes approx. 170 g in size were selected and stored at 12°C (above 90%RH) for 125 days. At regular storage intervals (0, 7, 15, 30, 45, 60, 75, 90, 110 and 125 days), 25 tubers were used to produce bruising.

Bruising method

Blackspot bruising was produced (Kunkel et al., 1986) by dropping a roundheaded plug (100g) from a height of 50cm onto the stem end, middle, and bud end at 12°C (Fig. 1). Bruised tubers were left for 48 hours at 15-20°C.

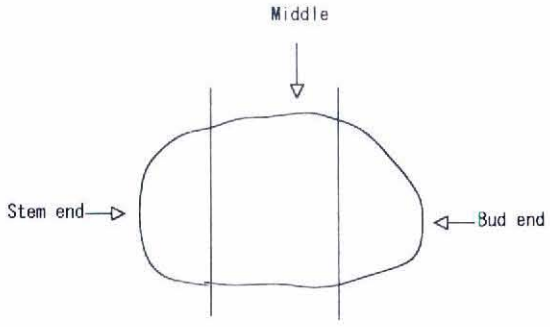

Fig. 1 The three potato tuber areas.

Bruise assessment

After 48 hours, 25 bruised tubers were used to assess the rate of the blackspot incidence and blackspot index described by Dwelle et al. (1976). The bruised areas were peeled until the discoloration was visible. The size and color intensity of the blackspots were considered and rated according to the following scale:

0 = no discoloration

1 = very small spots or vaguely defined

2 = diameter 3 to 5 mm, color gray or brownish

3 = diameter 5 to 10 mm, depth less than 5 mm, color gray to black

4 = diameter 5 to 10 mm, depth greater than 5 mm, color black

5 = diameter greater than 10 mm, depth greater than 5 mm, color black

Statistical analysis

The results were averaged to obtain mean values. Data was analyzed by the analysis of variance (ANOVA). When the F value was significant ($p<0.05$), Duncan's multiple range test of SPSS (1992) was used to compare means.

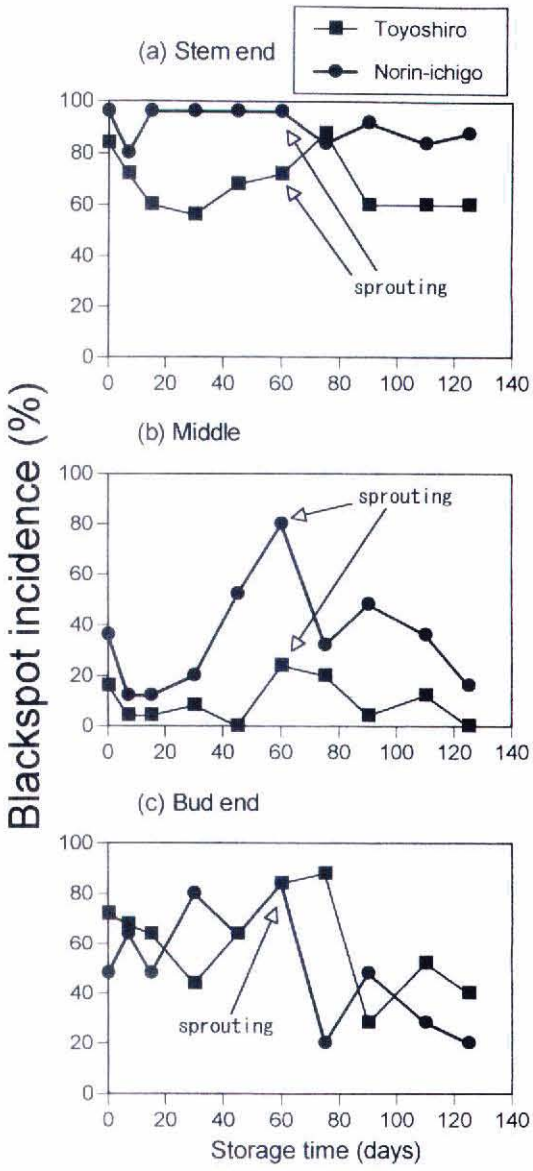

Fig. 2 Changes in the percentage of blackspot incidence of potatoes during storage.

RESULTS

Figure 2 shows changes in the blackspot susceptibility of Toyoshiro and Norin-ichigo potatoes during storage. For both cultivars, visible sprouting occurred at 60 days in storage on all tubers (25 tubers). At the stem end (Fig. 2a), the incidence of Toyoshiro cultivar was high at initial storage, but decreased until 35 days, then increased and peaked at 75 days, followed by a rapid decline. Norin-ichigo also had a higher incidence at initial storage and sprouting (60 days). In the middle portion (Fig. 2b), Toyoshiro and Norin-ichigo both had a higher incidence at initial storage, followed by a decrease, but at 60 days the incidence reached its maximum peak. The data on the bud end showed that both potatoes also had a higher incidence around initial sprouting (60 days) (Fig. 2c).

Table 1 indicates mean percentages of blackspot incidence over storage time. As shown in the table, the blackspot incidence was higher at initial storage and sprouting (60 days); the stem end had a high susceptibility to blackspot bruising compared with the other two areas (middle and bud end); and Norin-ichigo was more susceptible than Toyoshiro.

Table 1 Mean percentage of blackspot incidence of two processing potatoes over storage period

Storage period									
0	7	15	30	45	60	75	90	110	125(days)
58.9ab[1]	49.0b	49.9b	50.2b	55.8ab	73.4a	54.6ab	47.4b	47.3b	37.3c
Area									
Stem end			Middle			Bud end			
79.2a			22.8c			55.2b			
Cultivar									
Norin-ichigo					Toyoshiro				
59.1a					45.6b				

[1]Means in each row with same letter are not significantly different ($p<0.05$).

Figure 3 shows changes in the blackspot index during storage. At the stem end (Fig. 3a), Toyoshiro and Norin-ichigo followed the same trends as in Fig. 1a; both had a higher index at initial storage and around initial sprouting (60 days). In the middle (Fig. 3b), both potatoes again showed a higher score at initial storage and sprouting (60 days). Furthermore, at the bud end (Fig. 3c), both potatoes had a higher value also at initial storage and sprouting (60 days).

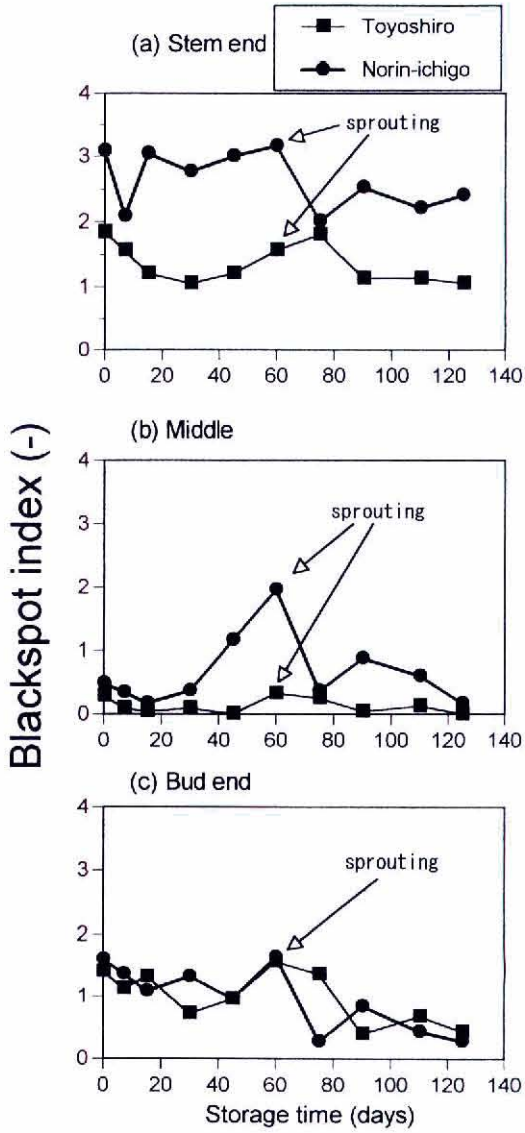

Fig. 3 Changes in blackspos index of potatoes during storage.

Table 2 indicates the effects of storage time, tuber area, and cultivar on the blackspot index. Similar to the results in Table 1, the blackspot index was high at initial storage and sprouting (60 days), and the stem end was most susceptible to bruising. Moreover, Norin-ichigo was more susceptible than Toyoshiro.

Table 2 Mean blackspos index of two processing potatoes over storage period

Storage period									
0	7	15	30	45	60	75	90	110	125(days)
1.41ac[1]	1.09ac	1.14ac	1.04c	1.28ac	1.66ab	1.01c	0.98c	0.86c	0.74d

Area		
Stem end	Middle	Bud end
1.99a	0.37c	1.00b

Cultivar	
Norin-ichigo	Toyoshiro
1.42a	0.82b

[1]Means in each row with same letter are not significantly different ($p<0.05$).

DISCUSSION

With respect to changes in the bruise susceptibility of potatoes during storage, Mondy et al. (1960) indicated that discoloration as a measure of bruise susceptibility increased with storage duration. However, Schippers (1971) stated that bruise susceptibility decreased slowly in storage. The result of our experiments (Table 1 and 2) revealed that at the beginning of storage and at sprouting, the bruise susceptibility was higher than at other storage periods.

It has been reported that the stem end of tubers was usually more susceptible to blackspot than the bud end (Sawyer and Collin, 1960 ; Kunkel and Gardner, 1959 ; Kunkel et al., 1978). The same results were obtained in the present experiments (Table 1 and 2).

Regarding the difference in blackspot susceptibility accoding to varieties, many researchers have found large differences. Workman (1984) reported on 11 clones that varied significantly in susceptibility. Sawyer (1960) also found that varieties differ in blackspot susceptibility. Thornton and Workman (1987) examined differences in the susceptibility of four cultivars ('Centennial Russet', 'Lemhi Russet', 'Russet Burbank', and 'BC9289-1'), and found that 'Lemhi Russet' and 'Russet Burbank' are susceptible to blackspot, while 'Centennial Russet' and 'BC9289-1' are resistant. In the present study, there was also a significant difference ($p<0.05$) between the two cultivars, with Norin ichigo showing a much higher susceptibility than Toyoshiro (Table 1 and 2).

Many factors influence the development of black spot due to bruising. Impact damage during harvesting and handling causes bruising and eventually blackspot (Miyamoto, 1978a, b ; Pavek, et al., 1985 ; Skrobacki, et al., 1989). Soil condition (Potato Marketing Board, 1974), tuber temperature (McRae et al., 1976) and fertilization (Robert et al., 1977) all play vital roles in the development of black spot in bruised potato tubers.

In addition to the above external factors, the role of the biochemical components of tubers is important. Browning in potatoes has been correlated with Polyphenoloxidase (PPO) activity and the concentrations of PPO substrates (Matheis and Belitz, 1978 ; Brudzynski and Zawidzka-Okoniewska, 1979 ; Stark et al., 1985 ; Matheis, 1987). Matheis and Belitz (1978) concluded that enzymatic browning in potatoes was correlated with tyrosine turnover, a parameter which depends on the concentrations of PPO, tyrosine, chlorogenic acid and ascorbic acid, rather than on any single factor. As pointed out by Dean et al. (1993), blackspot bruising of potato tubers depends on the susceptibility of the tissue to mechanical injury and its biochemical potential for pigment development. Thus, further studies related to the physical and biochemical properties of potatoes during storage are required.

The results of this investigation strongly suggest the need for cautious handling of potato tubers following storage, particularly at initial storage and sprouting, in order to reduce blackspot.

CONCLUSION

Norin-ichigo and Toyoshiro potatoes had a high incidence of blackspot bruise at initial storage and sprouting (Norin ichigo being more susceptible), and the stem end of the potatoes was most susceptible, followed by the bud end and middle.

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加工用貯蔵馬鈴薯の皮下黒変

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和 文 摘 要

農林1号およびトヨシロの4ヵ月間の貯蔵実験(12℃)を行い，馬鈴薯の皮下黒変の推移を検討した。皮下黒変は，貯蔵初期および萌芽期に高く，品種間では，トヨシロよりも農林1号の方が，皮下黒変になり易かった。さらに，部位間では，基部が，中央および頂芽部に比べ，皮下黒変感受性が高かった。

キーワード：加工用馬鈴薯，貯蔵，皮下黒変