

Technical Notes

Relative resistance of potato varieties to serious mechanical injury

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Misener, G.C. and Tai, G.C.C. 1993. Relative resistance of potato varieties to serious mechanical injury. *Can. Agric. Eng.* 35:289-291. The varietal susceptibility of potatoes to serious mechanical injury was investigated over a three-year period. Results from the study indicated a relative consistency in terms of ranking from year to year of the varieties to their susceptibility to injury. The study suggested that proper selection of varieties based on their susceptibility to injury can have a major impact on the quantity of seriously injured potatoes due to the harvesting operation.

Nous avons étudié la susceptibilité aux dommages mécaniques de plusieurs variétés de pomme de terre cultivées au Canada durant une période de trois ans. Les résultats obtenus ont montré que le classement de ces variétés en termes de leur susceptibilité aux dommages mécaniques demeure relativement constant d'une année à l'autre. Nos résultats semblent également indiquer qu'une sélection appropriée des cultivars en fonction de cette susceptibilité aux dommages mécaniques peut résulter en d'importantes variations de quantités de pommes de terre sérieusement endommagées par les équipements de récolte.

INTRODUCTION

Studies conducted by Misener et al. (1989) indicated that the amount of mechanical injuries imparted to potatoes during harvesting and subsequent handling was the most significant factor affecting the percentage of marketable tubers. Normal harvesting, as conducted in New Brunswick, resulted in 60% more post storage losses of marketable potatoes than hand harvesting. Tuber injuries were evident in 80% by weight of the harvested potatoes. Causes for the high levels of tuber injuries have been reported by Hudson and Orr (1977), Hyde et al. (1979), McRae (198_), and Peterson et al. (1975).

Variety susceptibility to mechanical injury has been studied by several researchers (Hamilton 1973; Strobacki et al. 1989; Blight and Hamilton 1974; Grant and Hughes 1985; Finney et al. 1964). The researchers found that significant differences in resistance to an applied physical stress or impact exist among potato varieties. As an example, Finney et al. (1964) found that the variety Kennebec required a significantly lower stress to rupture the tuber skin when compared to Russet Burbank, Katahdin, Sebago, and Onaway varieties.

The objective of this study was to rate the common varieties of potatoes grown in Canada as to their resistance to serious mechanical injury. The study was aimed at injuries

which separate the potatoes as non-marketable as this has a direct effect on economic returns to the potato industry.

MATERIALS AND METHODS

For a laboratory test to reliably subject potatoes to physical treatments similar to those encountered in the harvesting operation, it must consider the many factors which affect the level of injury imparted to the tubers. These factors include type of agitation, number of drops, and opportunities for crushing and gouging. A test circuit was developed to simulate the conditions found on harvesters (Fig. 1). Potatoes were placed on a webbed conveyor which in turn deposited them onto a second webbed conveyor running perpendicular to the first one. The potatoes then passed to a belted conveyor and onto a rotating drum. Another two conveyors completed the circuit. In total, the potatoes travelled 17.1 m, similar to a typical harvester (Hyde et al. 1983) and dropped through an accumulated distance of 1840 mm (seven drops) including the drum. The drum diameter was 760 mm, had 12 evenly spaced 25 mm internal flights, and rotated at 14 rpm. The maximum height that a tuber would drop would be the diameter of the drum if it were forced to fall from the top of the

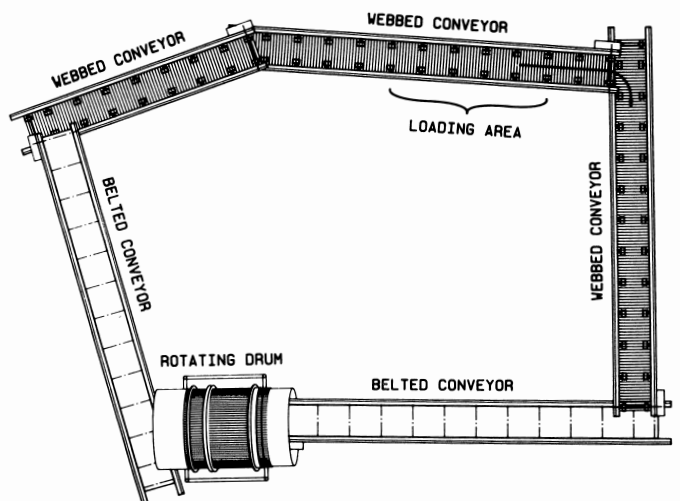


Fig. 1. Test circuit used to simulate harvester conditions.

rotating drum. The potatoes required 200 s to travel once around the circuit. The circuit simulated the conditions such as the transfer of potatoes from conveyor to conveyor that tubers encounter while passing through a harvester. Initial sampling of tubers passing through the circuit suggested that injury levels were higher than those encountered on commercial farms (Misener et al. 1989). This allowed us to provide a critical rating on the potatoes for their susceptibility to serious injury.

The potatoes were grown at the Research Station following standard recommended crop management practices. The vine killing treatment was applied in mid-September. This allowed all cultivars to have an equal and full-growing season, and thus their tubers were physiologically matured. The potatoes were treated with the chemical desiccant diquat (0.75 kg/ha). Two weeks after the date of the vine killing application, potatoes were dug by a small single hill digger and harvested by hand. Samples of 30 kg were manually selected and placed in trays. All tubers were carefully inspected to ensure that they were free from mechanical injury. The samples were then randomly passed through the test circuit that subjected all the samples to the same level of abuse. The samples were then stored at room temperature for 3 weeks and assessed for mechanical injury.

Analysis of variance was carried out for the incidence of serious injury of tubers of the 17 cultivars tested in 1989, 1990, and 1991. An intra-class correlation coefficient, R , was calculated based on the mean squares for cultivars and remainder in the analysis of variance table (Steel and Torrie 1980):

$$R = \frac{\hat{\sigma}_v^2}{\hat{\sigma}_v^2 + \sigma_r^2} \quad (1)$$

where:

$\hat{\sigma}_v^2$ = variance component for varieties = [MS(cultivars) - MS(Remainder)]/n,

σ_r^2 = variance component for remainder = MS (Remainder), and

n = number of years.

R represents a measure of consistency of the injury performance over years.

RESULTS AND DISCUSSION

Over the three years, the relative ranking of the varieties with regard to the incidence of serious injury was reasonably constant (Table I). Belmont and Sebago were consistently the most resistant to serious injury while Fundy and Green Mountain were the most susceptible varieties. Results of the analysis of variance of the incidence of tuber injury are shown in Table II. There were significant differences between years and highly significant differences between varieties. An intra-class correlation, R , which measured the resemblance of tuber injury readings of the varieties over years was determined to be 0.67** which is moderately high in magnitude. This value indicates that the relative response of the tubers to injury is relatively consistent over years.

The mean percent of tubers with serious injury for the 17 varieties is shown in Table III. Duncan's multiple range test

Table I. Percent (by weight) of tubers with serious injury for 17 varieties of potatoes

Variety	1989		1990		1991	
	%	Rank	%	Rank	%	Rank
Belmont	13.3	1	12.2	2	21.8	3
Chaleur	17.1	2	23.7	8	38.8	11
Sebago	24.8	3	15.7	3	21.4	2
Shepody	25.6	4	31.8	11	14.4	1
Jemseg	26.8	5	26.0	9	30.4	6
Norchip	27.8	6	10.8	1	27.9	4
Yukon Gold	30.3	7	22.3	6	41.9	13
Caribe	32.3	8	20.8	4	36.0	8
Kennebec	34.6	9	38.7	13	36.9	9
Russet						
Burbank	36.1	10	53.2	16	39.5	12
Saginaw						
Gold	38.1	11	27.7	10	55.3	15
Superior	39.7	12	35.4	12	44.3	14
Red						
Pontiac	42.2	13	23.3	7	29.4	5
Atlantic	44.0	14	21.1	5	37.2	10
Acadian						
Russet	48.4	15	39.2	14	34.4	7
Green						
Mountain	59.0	16	62.4	17	59.2	16
Fundy	75.4	17	45.4	15	72.0	17

Table II. Analysis of variance for tuber injury

	Degree of freedom	Mean squares	E(MS)
Year	2	340.09*	
Cultivars	16	494.36**	$3\sigma_v^2 + \sigma_r^2$
Remainder	32	71.77	σ_r^2

*, **: Significant at P = 0.05, 0.01, respectively

showed that Fundy and Green Mountain were most susceptible to serious injury. The most resistance group included Red Pontiac, Yukon Gold, Caribe, Jemseg, Shepody, Chaleur, Norchip, Sebago, and Belmont. It is interesting to note that Jemseg, Chaleur, and Belmont are early varieties, and Yukon Gold and Caribe are mid-season to early varieties. The late harvest of these potatoes may contribute to their resistance.

The mechanical device apparently is capable of simulating the injury of tubers during harvesting operation. The results proved that physiologically matured tubers of cultivars do have differential degrees of resistance to serious injury during harvesting operation.

Table III. Mean percent (by weight) of tubers with serious injury for 17 varieties of potatoes in descending order

Variety	Serious Injury (%)	Rank*
Fundy	64.3	a
Green Mountain	60.2	a
Russet Burbank	42.9	b
Acadia Russet	40.7	b
Saginaw Gold	40.4	b
Superior	39.8	b
Kennebec	36.8	b c
Atlantic	34.1	b c d
Red Pontiac	31.6	b c d e
Yukon Gold	31.5	b c d e
Caribe	29.7	b c d e
Jemseg	27.7	b c d e
Shepody	23.9	c d e
Chaleur	23.2	c d e
Norchip	22.2	c d e
Sebago	20.6	d e
Belmont	15.8	e

*Means with the same letter are not significantly different at the P = 0.05 level according to Duncan's Multiple Range test.

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