Performance Evaluation of Commercial Wild Blueberry Harvester for Fruit Losses During Harvesting

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DBE DOUG BRAGG ENTERPRISES

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Introduction

Wild blueberry (*Vaccinium angustifolium* Ait.) is an important horticultural commodity native to Northeastern North America. The mechanically harvested wild blueberry area is more than 80% of the total area in Canada and only the fields in rough terrain are still hand raked. In the last two decades, improved management practices using selective herbicides, fertilizers, pesticides and pollination have resulted in healthy and tall plants, high plant density, tall weeds and significant increase in fruit yield.

Wild blueberry industry is facing increased harvesting losses with the existing harvester due to changes in crop conditions caused by improved management practices emphasizing the need to enhance berry picking efficiency of the harvester. Therefore, the objective of this work was to evaluate the existing commercial wild blueberry harvester for fruit losses during harvesting.

Materials and Methods

- Three wild blueberry fields were selected in the Nova Scotia and New Brunswick provinces to evaluate the commercial blueberry harvester (Fig. 1).

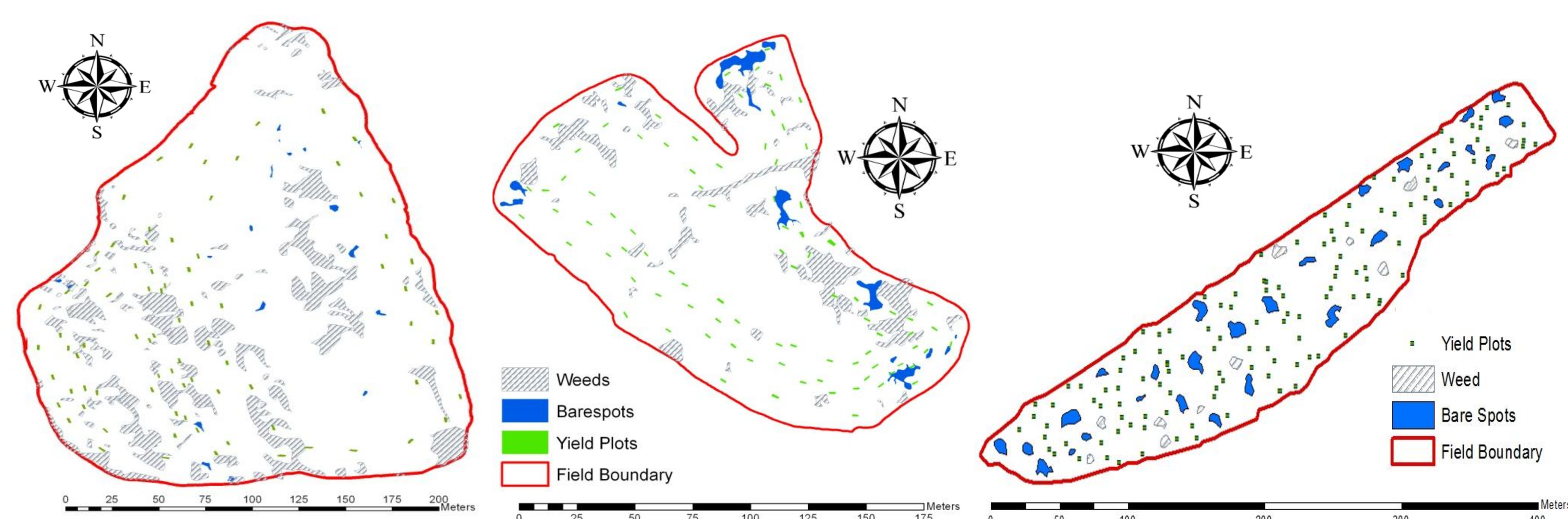

Figure 1. Layouts of selected wild blueberry fields (Left) Cooper site (Middle) Small Scott site and (Right) Tracadie site.

- Factorial experiments (3 x 3) were designed at each site to examine the picking efficiency of the harvester.
- Eighty one yield plots (0.91 x 3 m) were selected randomly in each field. The field boundaries, bare spots, weeds and yield plots were mapped with a real-time kinematics global positioning system .
- The pre-harvest fruit losses were collected manually from each plot prior to harvest the selected plot (Fig. 2a).
- The harvester was operated at specific levels of ground speed (1.2, 1.6 and 2.0 km h^{-1}) and header revolutions (26, 28 and 30 rpm).
- The treatment combinations were assigned randomly, and replicated nine times in each field.
- The harvester head was raised with the machine running to expel all the previously harvested fruit in the storage bin prior to harvest the experimental plot.
- Total yield was collected from each plot by attaching a bucket to the harvester conveyer (Fig. 2b).
- The yield loss via blower was collected by attaching a bucket under the blower fan (Fig. 2b).
- Berries on the ground and un-harvested berries on the plants were manually picked from each plot (Fig. 2a).

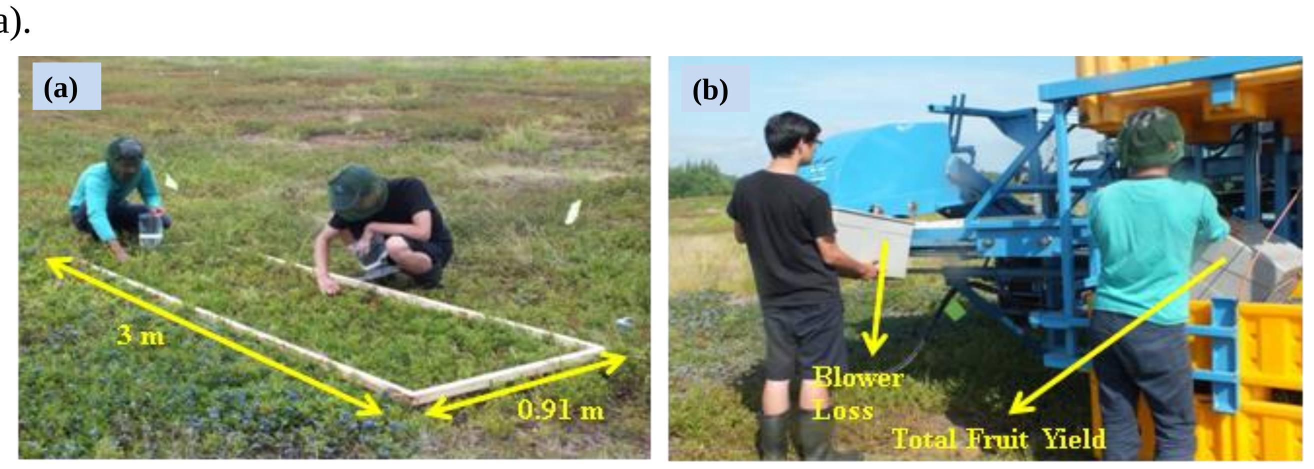

Figure 2. (a) Manual collection of losses on the ground and un-harvested berries on the plants; (b) Collection of fruit losses through blower and total fruit yield from plot.

- The collected berries were cleaned to record the actual weight of fruit yield and losses in kilogram from each plot.
- Factorial analysis of variance (ANOVA) was performed to study the joint effect of the selected factors on fruit losses and the means were compared using least squares (LS) method.

Results and Discussion

- Results suggested 182 kg ha^{-1} (4.68%), 207 kg ha^{-1} (7.33%) and 439 kg ha^{-1} (7.31%) of pre-harvest fruit losses for Cooper, Small Scott and Tracadie sites, respectively (Fig. 3).
- The late season harvesting (August 28 – September 10) could be the reason for higher pre-harvest losses at Small Scott and Tracadie sites.

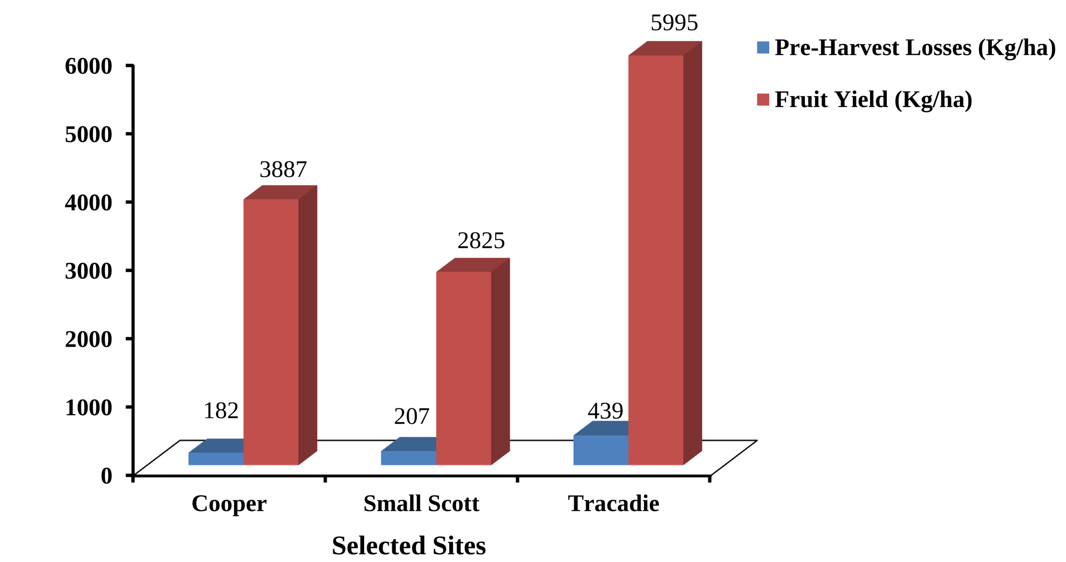

Figure 3. Bar charts of pre-harvest fruit losses and fruit yield during harvesting for selected fields.

- Results of ANOVA suggested that the fruit losses during harvesting were influenced by the ground speed and header revolutions either alone or in combination suggesting that a suitable combination of these parameters can results in better picking efficiency (Table 1) .

Table 1: Analysis of variance using two factor factorial design for selected fields.

Source	Un-harvested Berries (kg ha^{-1})	Berries on the Ground (kg ha^{-1})	Loss through Blower (kg ha^{-1})	Total Loss (kg ha^{-1})	Total Loss (%)	Fruit Yield (kg ha^{-1})
Cooper site						
Speed	NS	NS	NS	NS	NS	NS
Revolution	NS	NS	*	NS	NS	NS
Speed*Revolutions	*	*	NS	*	*	*
Small Scott site						
Speed	NS	NS	NS	NS	NS	NS
Revolution	NS	NS	NS	NS	NS	NS
Speed*Revolutions	*	*	*	*	*	*
Tracadie site						
Speed	*	NS	*	NS	NS	NS
Revolution	NS	NS	NS	NS	NS	NS
Speed*Revolutions	*	*	NS	*	*	*

Significance indicated by * and NS = non-significant at p = 0.05.

- The un-harvested berries on the plants were lower at 1.2 km h^{-1} and 26 rpm for selected sites suggesting that the lower ground speed and rpm can increase picking efficiency by minimizing the un-harvested berries on the plants (Table 2).
- Result showed that the losses on the ground were significantly higher than the un-harvested berries on the plants and losses through blower (Table 2).
- In high yielding sites a combination of 1.2 km h^{-1} and 26 can reduce losses on the ground during harvesting.
- The mixed trend of the losses through blower for selected sites suggested that the blower losses during harvesting were not affected by the treatment combinations (Table 2).
- Results of LS means comparison reported that the best treatment combinations with minimum total losses (kg ha^{-1}) were 1.2 km h^{-1} and 28 rpm, 2.0 km h^{-1} and 26 rpm and 1.2 km h^{-1} and 26 rpm for Cooper, Small Scott and Tracadie sites, respectively (Table 2).
- Since the total losses (%) are dependent upon the fruit yield collected from each treatment, therefore, there was mixed trend for total losses (%) in selected sites (Fig. 4).
- Results indicated that a combination (2.0 km h^{-1} and 30 rpm) can result in increased losses in high yielding fields during harvesting.
- Overall, the efficiency of the blueberry harvester was 92% (8% losses) for Cooper and 88% (<12% losses) Tracadie sites at 1.2 km h^{-1} and 26 rpm. The picking efficiency of the harvester was 94% (6% losses) at 2.0 km h^{-1} and 26 rpm for Small Scott site (Fig. 4).
- Fruit losses during harvesting are not only due to machine, but a function of the several parameters (biological factors, operator skills, filed conditions, time of harvesting, weather conditions, bare spots and weed coverage). These factors need to be studied in future to identify the sources of losses.

Table 2. Results of multiple means comparison using least-squares method to identify the two way interaction effects on fruit losses during harvesting..

Treatment	Speed (km h^{-1})	RPM	Un-harvested Berries (kg ha^{-1})	Berries on the Ground (kg ha^{-1})	Loss through Blower (kg ha^{-1})	Total Loss (kg ha^{-1})	Fruit Yield (kg ha^{-1})
Cooper site							
1	1.20	26	80.5 AB	245.9 C	81.6 A	408 B	5116 A
2	1.20	28	90.3 AB	165.4 D	25.0 B	280.7 D	1899 D
3	1.20	30	105 AB	340.6 AB	32.2 B	477.8 A	3783 B
4	1.60	26	54.2 B	268.7 BC	41.3 B	364.2 BC	3437 BC
5	1.60	28	114.2 A	330.7 AB	41.9 B	486.8 A	4398 AB
6	1.60	30	59.8 B	403.6 A	43.5 B	506.9 A	4368 AB
7	2.0	26	81.6 AB	270.9 BC	59.8 AB	412.3 B	3490 BC
8	2.0	28	103.3 AB	281.8 BC	28.3 B	413.4 B	3877 B
9	2.0	30	63.1 B	311.3 B	37.5 B	411.9 B	3368 BC
Tracadie site							
1	1.20	26	74.2 CD	527 BC	60.4 B	661.7 C	6044 A
2	1.20	28	76.7 BCD	637.9 A	63.4 AB	778 AB	5726 A
3	1.20	30	88 BCD	603.9 ABC	62.5 AB	754.4 BC	5500AB
4	1.60	26	94.7 BCD	582.5 ABC	58.7 B	735.9 BC	5350AB
5	1.60	28	107.1 ABC	653.8 A	78.9 A	839.8 A	6300 A
6	1.60	30	79.5 BCD	635.9 A	65.7 AB	781.2 A	5435AB
7	2.0	26	130.3 A	505.6 C	56.6 B	692.5 CD	4510 B
8	2.0	28	71.9 D	652 A	62.2 AB	786.1 A	5604AB
9	2.0	30	108 AB	579 ABC	64.6 AB	751.5 AB	4575 B

Means with no letter shared are significantly different at p = 0.05.

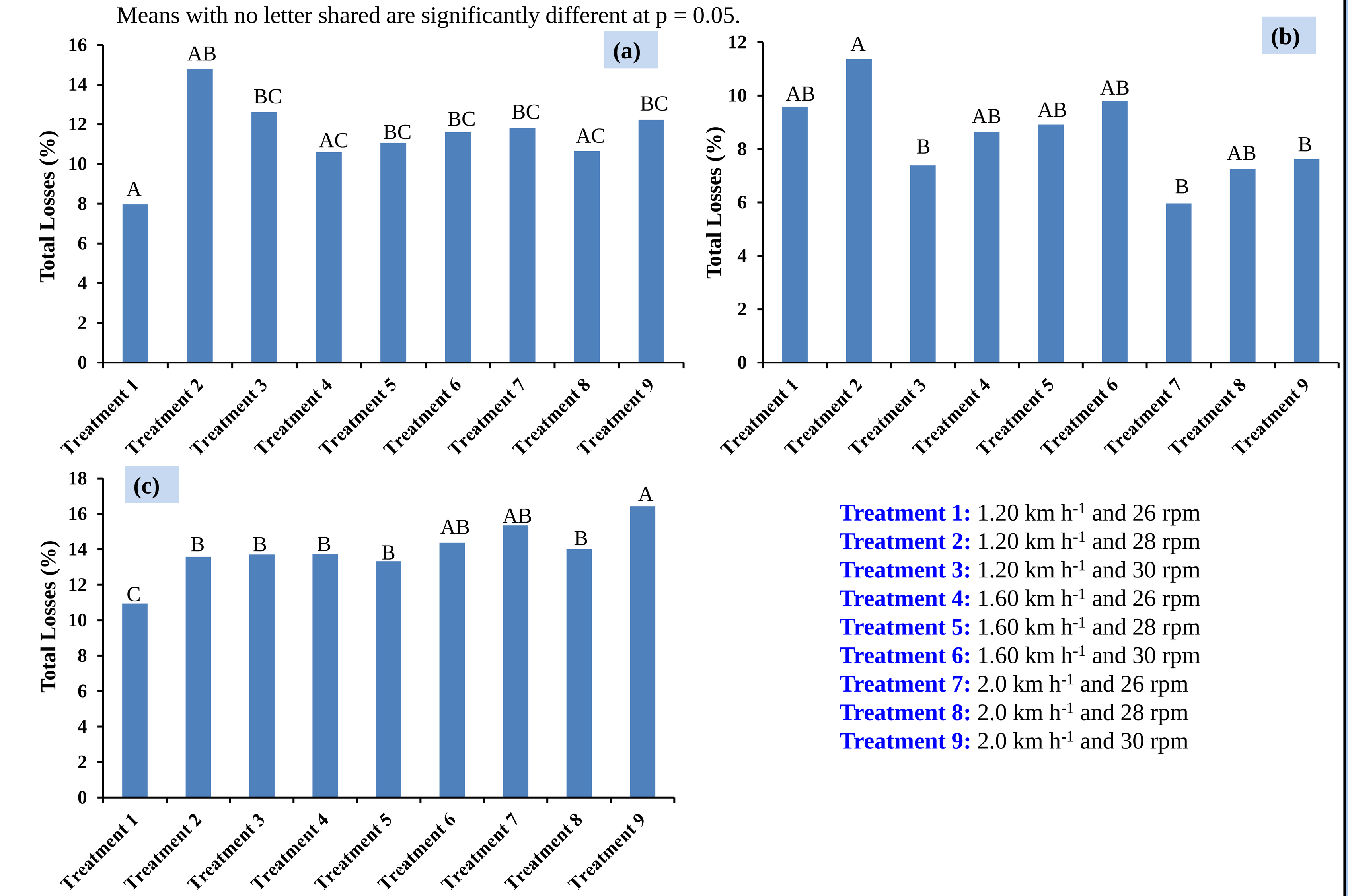

Figure 4. Mean comparison of total losses (%) for (a) Cooper site (b) Small Scott site and (c) Tracadie site.

Conclusion

- The major portion of the fruit losses during harvesting was on the ground when compared with the un-harvested berries on the plants and losses through blower.
- The results showed that a treatment combination of 1.2 km h^{-1} and 26 rpm can result in significantly lower losses in wild blueberry fields with yield over 3500 kg ha^{-1}.
- In low yielding fields (Small Scott site) there was a mixed effect of treatment combinations on the berry picking efficiency of the blueberry harvester.
- In coming years the performance of harvester for berry picking will be studied in relation to mechanical, biological, environmental factors and operators skill in variable blueberry fields.

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