Potential Yield Loss Due to Weeds in Dry Beans in Canada and the United States

Nader Soltani[1]*, J. Anita Dille[2] and Peter H. Sikkema[1]

[1]University of Guelph Ridgetown Campus, Ridgetown, ON, Canada and [2]Kansas State University, Manhattan, KS, USA

INTRODUCTION

Previous Weed Science Society of America (WSSA) Weed Loss Committee reports by Chandler (1984), Bridges (1992), and Swanton et al. (1993) provided a summary of crop yield losses due to weeds in different regions of the United States and Canada. It has been nearly 25 years since the last WSSA Weed Loss committee report was published. Recent improvements in agronomic practices and crop cultivars may influence dry bean yield loss due to weed interference. It will be interesting to know if there have been any changes in yield loss estimates due to weed interference in the primary dry bean growing areas of the United States and Canada.

The objective of this WSSA Weed Loss Committee study was to provide a summary of the potential yield loss in dry bean due to weed interference based on quantitative data (from replicated, small plot research studies) from the primary dry bean growing regions of North America over a 10-year period (2007 to 2016).

METHODS

Research and/or extension weed specialists in the primary dry bean growing areas of the United States and Canada were requested to provide data on dry bean yield loss due to weed interference in their states and provinces (Table 1). Data requested included results from weed control studies in dry bean from up to 10 individual studies conducted within each calendar year during 2007 to 2016.

Each researcher/specialist was asked to provide the "weedy dry bean yield" and "weed-free dry bean yield" which was defined as the mean yield from plots with >95% weed control (based on normal agronomic practices for optimal dry bean yield with excellent weed control management programs).

To determine potential dry bean yield loss for each state or province, percent yield loss (YL%) was determined for each individual study, then averaged within a year, and averaged across the ten years (2007-2016) as follows:

Potential YL% = (weed-free yield – weedy yield)/weed-free yield * 100 [1]

Information on total dry bean harvested (hectares and acres), dry bean yield (tonnes ha^{-1} and lbs acre^{-1}), total dry bean production (tonnes and cwt), and yearly average commodity prices (US $/cwt) for each state or province were obtained from USDA-AMS (2017) and AAFC (2017) reports.

Since dry bean production among the states or provinces was variable, the monetary loss was weighted by the quantity of dry bean production within each state or province. The potential loss for each state or province was based on the product of the estimated amount of dry bean yield loss due to weed interference multiplied by the mean dry bean price for 2007 to 2016. Average dry bean price for the period of 2007 to 2016 was US $730 tonnes^{-1} ($33.04 cwt^{-1}) and was used to determine potential monetary loss (AAFC 2017; USDA-AMS 2017).

Figure 1. Dry bean growing regions within the United States and Canada.

Table 1. Annual average dry bean area harvested, yields, and total value as well as estimated yield loss (%), losses in dry bean production (kg ha^{-1}) and in value (US$) from weed interference for each state or province that provided data for the period of 2007 to 2016.

State or province	Harvested area	Average yield	Total Value	Yield loss	Potential loss in production	Potential loss in value ($0.73 kg^{-1} or $33.04 cwt^{-1})
	Hectares (acres)	kg ha^{-1} (lb acre^{-1})	US$ * 1000	%	kg ha^{-1}	US$ * 1000
United States						
Idaho	46,258 (114,300)	2,129 (1,904)	$71,906	50.2	1,069	$36,097
Michigan	83,491 (206,300)	2,083 (1,863)	$126,988	31.2	650	$39,620
Montana	12,469 (30,810)	1,966 (1,758)	$17,896	35.6	700	$6,371
Nebraska	51,195 (126,500)	2,532 (2,265)	$94,669	58.7	1,487	$55,571
North Dakota	362,819 (896,500)	1,701 (1,521)	$450,536	93.5	1,590	$421,251
South Dakota	4,456 (111,011)	2,169 (1,940)	$7,058	30.8	668	$2,174
Wyoming	14,051 (34,720)	2,550 (2,281)	$26,167	70.5	1,798	$18,448
Canada						
Ontario	48,455 (119,728)	2,204 (1,971)	$77,971	55.9	1,232	$43,586
Manitoba	44,608 (110,222)	1,871 (1,673)	$60,928	71.9	1,345	$43,807

Table 2. Annual total dry bean production (MT) and value (US$), and annual potential loss in production (MT) and value (US$) from weed interference for the United States and Canada based on 2016 production data
(Statista,https://www.statista.com/statistics/194283/us-bean-production-since-2000/ https://www.statista.com/statistics/449320/farm-cash-receipts-of-dry-beans-canada/).

Country	Total production	Value	Potential loss in production (based on 71.4% YL)	Potential loss in value (based on 71.4% YL)
	MT	US$	MT	US$
United States	1,318,000	$871,407,000	941,052	$622,184,598
Canada	258,000	$140,328,000	184,212	$100,194,192
Total	**1,576,000**	**$1,011,735,000**	**1,125,264**	**$722,378,790**

RESULTS AND DISCUSSION

Yield loss data were received from nine major dry bean growing areas of North America which collectively represent greater than 90% of dry bean grown in North America (Table 1; Fig. 1). Table 1 shows data averaged over the 10-year period (2007-2016) from these seven US states and the two Canadian provinces.

Results show that dry bean growers in Idaho, Michigan, Montana, Nebraska, North Dakota, South Dakota, Wyoming, Ontario and Manitoba would potentially lose an average of 50, 31, 36, 59, 94, 31, 71, 56, and 72% of their dry bean yield which equates to a monetary loss of US$36, 40, 6, 56, 421, 2, 18, 44 and 44 million, respectively, if they use their best agronomic practices without any weed management tactics.

Based on 2016 census, at an average yield loss of 71% for North America, dry bean production in the United States and Canada would be reduced by 941,000 and 184,000 MT out of their total production of 1,318,000 and 258,000 MT valued at approximately US$622 and US$100 million, respectively, to uncontrolled weeds (Table 2).

CONCLUSIONS

Dry bean growers in the United States and Canada would potentially lose 71% of their crop, with a monetary loss valued at US$722 million if they did not employ any weed management tactics.

The economic cost of weed interference in dry bean shows the need for continued applied weed science research to find new weed management options for dry bean growers in North America.

ACKNOWLEDGMENTS

We would like to thank the members of the WSSA Weed Loss Committee for their valuable input into this report. We also would like to thank Rob Gulden, Christy Sprague, Richard Zollinger, Don Morishita, Nevin Lawrence, Gustavo Sbatella, Andrew Kniss and Prashant Jha for providing data on the yield losses for their states/provinces.

REFERENCES

Agriculture and Agri-Food Canada [AAFC] (2017). Grain Statistics Weekly [Online]. Available: https://www.grainscanada.gc.ca/statistics-statistiques/gsw-shg/gswm-mshg-eng.htm.

Bridges DC (1992) Crop losses due to weeds in the United States – 1992. WSSA special publication, Champaign, IL.

Chandler JM, Hamill AS, Thomas AG (1984) Crop losses due to weeds in Canada and the United States. WSSA special publication, Champaign, IL.

Swanton CJ, Harker KN, Anderson RL (1993) Crop losses due to weeds in Canada. Weed Technol 7:537-542.

USDA-AMS (2017) Livestock and grain market news. [Online] Available: https:// www.ams.usda.gov/market-news/livestock-poultry-grain.