Potential For Wind Erosion As Affected By Management In Bean-Potato Rotations

A. Moulin and K. Volkmar
Agriculture and Agri-Food Canada, Brandon, Manitoba

ABSTRACT

The potential for soil erosion in the bean phase of bean-potato rotations is significant due to low levels of crop residue following potatoes and the effect of management on soil structure particularly in light textured soils typical of the potato growing area of Manitoba. This potential can be mitigated by fall cover crops, application of straw or composted manure. In a study at Carberry, MB crop residue cover from 2000 to 2004, the proportion of small erodible aggregates and stability of aggregates were measured in treatments with fall applied cereal, fall applied compost, and spring applied polymer. Crop residue cover, proportion of erodible aggregates and aggregate stability were not consistently affected by management over the short term. In some years application of cereal residue in the fall increased residue cover, reduced the proportion of small erodible aggregates (<0.5 mm) and increased stability of aggregates. Application of polyacrylamide did not affect stability of wet-sieved aggregates but decreased the proportion of small aggregates (<0.5 mm) in 2002. Further research is required to assess the long-term impact of management on potential for wind erosion and properties of soil aggregates in bean-potato rotations.

INTRODUCTION

Current recommendations for potato production refer to the importance of crop rotation and tillage management to address issues related to soil erosion (Manitoba Agriculture, Food, and Rural Initiatives 2004). Although sand or sandy loam textured soils are preferred for potato production, they are particularly susceptible to wind erosion. Rotation, crop residue management and tillage are the primary means of reducing the potential for erosion by maintaining crop residue cover (Manitoba Agriculture, Food, and Rural Initiatives 2004). Bean potato rotations are particularly susceptible to erosion given the low level of crop residue produced by beans and potatoes, and tandem disking associated with seedbed preparation for these crops. Cover crops such as fall rye are effective means of controlling wind erosion, but may not fit bean-potato rotations. Application of cereal straw or composted manure in fall, or polymers in spring, has been suggested as alternatives to a cover crop of fall rye.

Recent research in Prince Edward Island found that residue management in a 2-yr rotation reduced soil erosion as estimated by rainfall simulation by as much as 50% and tuber yields were not affected (Holmstrom et al 1999). In a subsequent study, Edwards and coworkers (Edwards et al 2000) found compost had no effect on soil loss but increased soil aggregate stability by 7%, while mulching reduced soil loss by almost 50%. Both treatments increased soil water content by 6-7% while soil penetration resistance below the root zone was reduced almost 20%. Levy and Miller (1999) reported a significant increase in aggregate stability after application of polyacrylamide. These practices have not previously been tested in Manitoba.

OBJECTIVE

The objective of this research was to determine the potential for wind erosion in bean potato rotations amended with cereal straw, manure or spring application of a polymer.

METHODS AND MATERIALS

A four-year field study was conducted at the Manitoba Crop Diversification Centre at Carberry MB from 2000 to 2004. The study was conducted on a selected on a Ramada clay loam (pH: 5.7; EC: 0.8 dS m^{-1}).

Two adjacent blocks were seeded to potatoes (variety Russet Burbank) and pinto beans (variety Envoy) respectively each year from 2000 to 2004. Fertilizer rates were based on a target of 199 kg ha-1 N and 134 kg ha^{-1} P for potatoes, and 119 kg ha-1 N and 67 kg ha^{-1} P for beans. The following treatments were established in 2000 in a randomized complete block design with four replicates:

Treatments:

- Control (no soil amendment)
- Cereal straw applied at 4 tonne ha^{-1} in the fall, in each year of the bean and potato rotation.
- Animal compost applied at rates ranging from 28 to 52 tonne ha^{-1} in the fall based on an equivalent rate of carbon application to straw, in each year of the bean and potato rotation.
- Polymer (polyacrylamide) applied in the spring after seeding in each year of the bean and potato rotation.

Plots were tandem disked once in the fall following potatoes, then tandem disked twice, harrowed and seeded to beans in spring. Plots in beans were tandem disked twice in the spring, cultivated with a Rotara rotary power cultivator.

In each year, crop residue cover was determined and soil samples were collected in the spring prior to or shortly after seeding to determine potential for erosion. Approximately 2.5 kg of soil was collected at the 0 to 5 cm depth increment at three locations in each plot. Samples are collected in the spring for the control, fall animal compost, fall cereal straw, spring polymer treatments. Samples are collected prior to and after application of polyacrylamide in the polymer treatments. Soil moisture data are also collected at the time of sampling. Soil samples are sieved with a rotary sieve and the weight in each of seven aggregate fractions (>38mm, 38 to 12.7 mm, 12.7 to 7.2 mm, 7.2 to 2.0 mm, 2.0 to 1.3 mm, 1.3 to 0.5 mm, < 0.5 mm) was recorded.

Aggregates in the 1.3 mm to 2.0 mm sieve fraction were collected during the sieving process. Wet stable aggregates were measured according to Kemper and Rosenau (1986). Soil carbon was also measured in this fraction.

Crop residue was measured using a grid system. Two digital images were recorded in the spring for the control, fall animal compost, fall cereal straw, spring polymer treatments. The images were projected on a grid of 144 points and the frequency of residue and non-residue points tabulated to calculate residue cover.

Data were analyzed with analysis of variance. Means of treatments significant at P<0.05 were compared with Tukey's honestly significant difference (SAS Institute 2002). Aggregate fractions were logarithmically transformed to the base 10 to ensure normal distribution of the data.

RESULTS AND DISCUSSION

Crop Residue Cover

The effect of management on crop residue cover was not consistent between years or crops. Treatment effects were not significant following beans in 2001 and 2004, and potatoes in 2002 and 2003. In 2002 fall application of cereal residue in plots following potatoes resulted in significantly higher residue cover than compost and control treatments (Figure 1). Crop residue cover was higher in 2001 due to fall application of cereal straw for plots following beans.

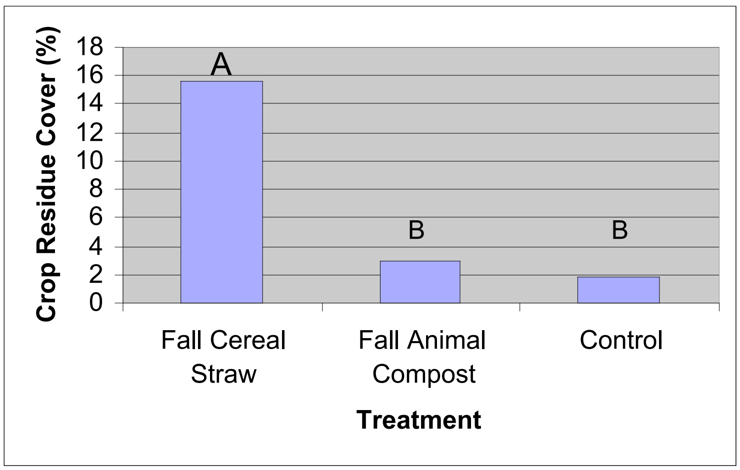

Figure 1. Crop residue cover in treatments for plot following potatoes, 2002. Letters indicate Tukey's honestly significant differences at P<0.05.

Distribution of Dry-Sieved Aggregates

The proportion of small erodible aggregates varied considerably, in all years, and was not consistent without significant treatment effects in most years for both beans and potatoes. In 2002 the proportion of aggregates < 0.5 mm ranged from 32 to 37 % and was significantly higher with cereal residue applied in the fall following potatoes (Figure 2).

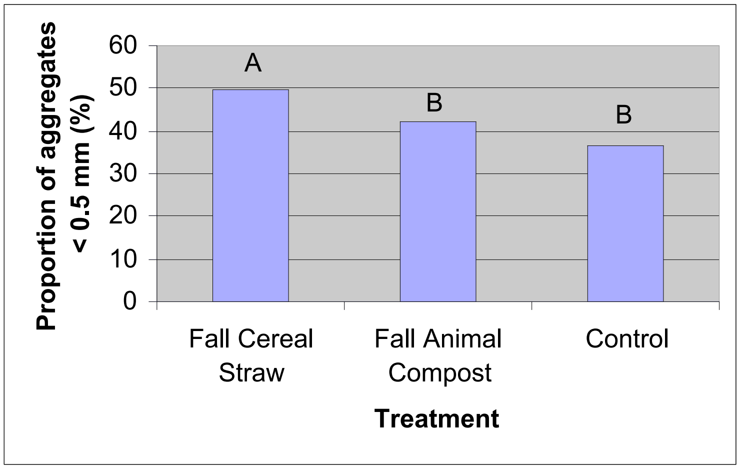

Figure 2. Proportion of dry-sieved aggregates < 0.5 mm in treatments for plot following potatoes, 2002. Letters indicate Tukey's honestly significant differences at P<0.05.

Stability of Wet Sieved Aggregates

Stability of wet-sieved aggregates was low in all treatments, without significant treatment effects in most years for both beans and potatoes. The sole exception was in 2001 where stability of aggregates < 0.5 mm was significantly higher following potatoes with cereal residue applied in the fall (Figure 3).

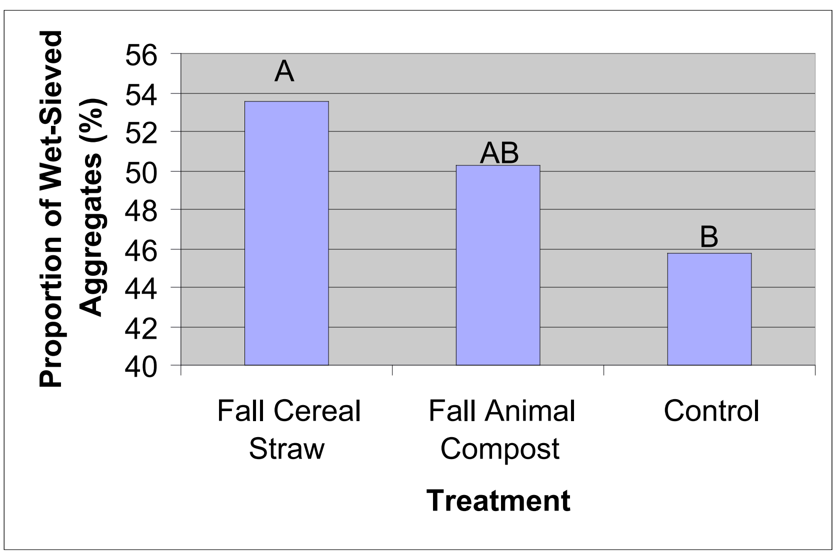

Figure 3. Proportion of wet-sieved aggregates in treatments for plot following beans, 2001. Letters indicate Tukey's honestly significant differences at P<0.05.

Effect of Polyacrylamide

Application of polyacrylamide did not significantly affect stability of wet sieved aggregates. The proportion of small aggregates (<0.5 mm) decreased significantly due to the application of polyacrylamide following bean and potato crops in 2002 (Figure 4) but not in 2001 or 2003.

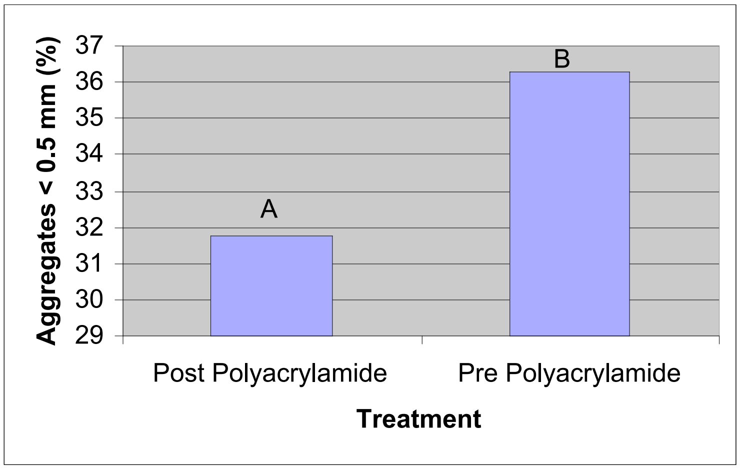

Figure 4. Proportion of dry-sieved aggregates due to application of polyacrylamide following beans, 2002. Letters indicate Tukey's honestly significant differences at $P<0.05$.

CONCLUSIONS

Crop residue cover, proportion of erodible aggregates and aggregate stability were not consistently affected by management over the short term. In some years application of cereal residue in the fall increased residue cover, reduced the proportion of small erodible aggregates (<0.5 mm) and increased stability of aggregates. Application of polyacrylamide did not significantly affect stability of wet sieved aggregates in 2001 and 2003, but decreased the proportion of small aggregates (<0.5 mm) in 2002. Further research is required to assess the long-term impact of management on potential for wind erosion and properties of soil aggregates in bean-potato rotations.

REFERENCES

1. **Edwards, L.; Burney, J. R.; Richter, G., and MacRae, A. H. 2000** Evaluation of compost and straw mulching on soil-loss characteristics in erosion plots of potatoes in Prince Edward Island, Canada. Agriculture Ecosystems & Environment. Nov; 81(3):217-222.
2. **Holmstrom, D.; DeHaan, R.; Sanderson, J. B., and MacLeod, J. A. 1999** Residue management for potato rotation in Prince Edward Island. Journal of Soil & Water Conservation.; 54(1):445-448.
3. **Levy, G. J. and Miller, W. P. 1999** Polyacrylamide adsorption and aggregate stability. Soil & Tillage Research. Jul; 51(1-2):121-128
4. **Manitoba Agriculture, Food, and Rural Initiatives. 2004** Commercial Potato Production - Field Selection, Soil Management and Fertility. [Online] 18 Jan, 2005. http://www.gov.mb.ca/agriculture/crops/potatoes/bda04s04-3-4.html

5. **SAS Institute Inc. 2002**. JMP Statistics and Graphics Guide. Version 5.01a. Cary, NC: SAS Institute Inc.; pp 707.