Canadian Journal of Soil Science
Revue canadienne de la science du sol

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Journal:	<i>Canadian Journal of Soil Science</i>
Manuscript ID	CJSS-2017-0062.R1
Manuscript Type:	Short Communication
Date Submitted by the Author:	17-Jul-2017
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Agronomists' Views on the Potential to Adopt Beneficial Greenhouse Gas Nitrogen Management Practices Through Fertilizer Management

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Abstract

Agronomists in Manitoba, Canada, are willing to reduce soil nitrous oxide emissions. They consider: enhanced efficiency fertilizers if cost-effective; both crop yield and financial returns to be important for application rate; preferred fall instead of spring application because of operational advantages; and using banding placement if appropriate equipment is available.

Introduction

About 3% of Canada's greenhouse gas emissions are from direct nitrous oxide (N_2O) emissions during agricultural production (Environment Canada 2015). These emissions are mostly caused by application of nitrogen (N) fertilizers, where about 1 to 4% of applied N is lost directly or indirectly from soil as N_2O , a gas that has about 265 times more global warming potential than carbon dioxide in the atmosphere (Myhre et al. 2013). The agricultural industry has been researching Beneficial Management Practices (BMPs) with the aim to reduce these soil emissions. One of the main strategies is to pay attention to N fertilizer source, rate, timing, and placement, often known as the "4Rs" (e.g., Snyder et al. 2009). Agronomists influence the adoption of the 4Rs through their recommendations and discussions with agricultural producers. We were interested in canvassing current thoughts and approaches of agronomists about BMPs that could reduce N_2O emissions. We recognize that agronomists are a diverse group, which include consultants, producers and researchers; and they interact regularly in a variety of capacities. We surveyed a broad group of agronomists about their views on the potential

to adopt beneficial greenhouse gas nitrogen management practices through fertilizer management. This type of information is important to help guide the development and implementation of technologies, techniques and policies that will encourage reduction of N₂O emissions from N fertilization.

Methods

The 2015 Manitoba Agronomist Conference hosted about 200 people on site (Winnipeg), with about another 200 agronomists attending through an internet video link to remote locations. The conference tends to attract agronomists engaged in continuing education on various practices. We first presented a 30-minute overview of enhanced efficiency fertilizers and beneficial greenhouse gas nitrogen management practices (Tenuta et al. 2015). This presentation covered the main knowledge points related to the 4Rs of N fertilizer management. The presentation incorporated general, regional, and local evidence of N₂O emissions affected by source (Breitenbeck and Bremner 1986, Tenuta and Beauchamp 2003, Gao et al. 2015); rate (Gao et al. 2013, Glenn et al. 2012, Maas et al. 2013); timing (Tenuta et al. 2016); and placement (Gao et al. 2015). Immediately following the presentation, we canvassed the audience using i>clickers[®] (iclicker.com) to provide immediate answers to questions about N fertilizer usage and attitudes. The questions were asked with a maximum of five answer choices (Amiro et al. 2015). There was a brief explanation of the choices without interpretation and the full survey was completed within 30 minutes. For remote audiences, we provided a Survey Monkey[®] (surveymonkey.com) link to answer questions, which were supplied within two weeks.

Results and Discussion

Demographics of agronomists surveyed: A total of 135 (115 on site, and 20 through the on-line link) agronomists provided responses to most of the questions. The respondents were allowed to self-identify based on their main professional activity. Consulting agronomists and sales representatives (normally employed by a company or self-employed) constituted 42% of the population. The next largest category (29%) did not self-identify with any of the categories. Researchers represented 12% and agricultural producers were 9% of the population. Government employees were 7% and there were only 2 individuals that identified as students or non-research academics. More than half of the agronomists had less than 10 years' experience, although there was a wide distribution of experience: < 5 years (38%), 5-10 years (20%), 10-20 years (26%) and >20 years (21%). It is likely that our population is biased towards agronomists who have an interest in continuing education and learning new developments in agronomy.

General attitudes: The reduction of N₂O emissions was a high priority for 94% of respondents providing that it was cost-effective (Table 1), indicating a wide willingness to engage in potential mitigation measures. This included all of the producers in the audience.

Fertilizer source: Three questions were aimed at determining the views on fertilizer source use (Table 1). Conventional sources (granular urea, urea ammonium nitrate, anhydrous ammonia) were most commonly used or recommended among this population. Enhanced efficiency N fertilizers with some aspect of slow release (polymer coated urea (e.g., Environmentally Smart Nitrogen[®]), or those incorporating a urease

(e.g., Agrotain[®]) or nitrification (e.g. SuperU[®], N-Serve[®], Instinct[®]) inhibitor) were used by only a small fraction (13%) of the respondents. Despite the current practice, 63% were willing or very willing to use or recommend fertilizers with some potential environmental benefit. Another 35% of respondents would be willing if the cost was subsidized. If fertilizers with some potential environmental benefits cost less than 10% more than conventional fertilizers, 62% of respondents said that they would be willing to pay the differential, but 26% were not willing to pay more.

Fertilizer rate: The majority (63%) of respondents currently base their N application rate on the crop recommendation following soil testing for a yield goal, but there was a population that would use slightly more. This is likely with some optimism that there could be environmental conditions where this addition has a benefit. Potential high yields (44%) tended to be a lesser motivation than economic gain (56%) for the respondents when considering fertilizer application rate.

Fertilizer timing: A major decision in the timing of N fertilization for many field crops on the Prairies is whether to apply in fall or spring. For either of these main choices, there are many other timing considerations. For example, fall application needs to be done prior to the soil freezing, and there is often a wide window between crop harvest and soil freezing dates. The spring application could be done pre-seeding, with seed placement, or during the growing season. Our fall/spring-timing question indicated that only 16% of respondents didn't consider fall application. Two-thirds of respondents chose fall application because of workload and environmental conditions being more favourable than in spring. Fall fertilizer application close to freeze-up tends to have low

N₂O emissions because of cold temperatures (Tenuta et al. 2016), although we need much more information on potential emissions for a range of timing and conditions.

Fertilizer placement: For many Prairie crops, banding of N fertilizer is a recommended BMP to optimize delivery to the plant, with potential reductions in N₂O emissions and other N losses. When asked why banding was not chosen or recommended, about half of respondents said they usually band their N fertilizer, and about one third might do this if equipment was available (Table 1). There is likely an opportunity for further equipment development for fertilizing winter cereals and perennial forages. Placement of enhanced efficiency fertilizers was not different from other fertilizers for 40% of the respondents. However, 30% of respondents used less fertilizer when employing enhanced efficiency fertilizers.

Conclusions

Most agronomists take N₂O emissions seriously and our respondents expressed willingness to help reduce the emissions. There tended to be a stronger willingness by the younger population, but some producers and consultants with more than 20 years of experiences also said that reducing N₂O emissions should be a high priority. Agronomists were willing to use enhanced efficiency N fertilizers, but were concerned about profitability: there was less interest if costs were greater than 10% of that for their current products. Both yield and economics were important when considering the rate of application. On the Prairies, fall fertilizer N application often has operational advantages, with some cost advantages, and there may need to be substantial agronomic advantage for increased adoption of spring fertilizer application. Fertilizer banding could increase with

better equipment for those who are not presently banding in challenging cropping systems, perhaps requiring some economic incentive to develop and acquire equipment. Our survey highlighted several of the main opportunities and limitations to change N fertilization practices with the aim to reduce N₂O emissions. However, a larger population with more producer input would help to further develop BMPs that could be widely adopted. Nevertheless, the results of this survey may serve as a tool to guide policy-makers and agricultural industry leaders as we try to develop an acceptable approach for reducing N₂O emissions from agricultural land.

Acknowledgements

The research on the development of potential beneficial management practices was supported by a large number of agencies: The Government of Canada (Agriculture and Agri-Food Canada Agricultural Greenhouse Gas Program, Canada Research Chairs, NSERC Discovery Program, Growing Forward, AgriInnovation Program, Canadian Foundation for Innovation, Canada-Manitoba Crop Development Centre), the Province of Manitoba (Manitoba Sustainable Agricultural Practices Program, Manitoba Rural Adaptation Council, Municipal Rural Infrastructure Program), grower co-operators and organizations (Manitoba Corn Growers Association, Western Grains Research Foundation, Manitoba Pulse and Soybean Growers Association, Keystone Potato Producers Association), and industry (Agrium, KOCH, BASF, DOW, Fertilizer Canada, McCains, SimPlot). We also thank the many staff, students and colleagues who have contributed research knowledge.

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Table 1. Responses to Survey Questions. Note that percentages may not sum to 100

because of rounding and neglecting answers with fewer than 3 respondents.

Question	Response
Providing that it is cost-effective, do you believe that the reduction of N ₂ O emissions should be a high priority? (Viewpoint)	33% Strongly Agree; 61% Agree; 4% Disagree (n=127)
What type of N fertilizer do you <i>most commonly</i> prefer for your typical crop rotation? (Source)	86% Conventional; 8% Polymer Coated Urea; 3% Urease inhibitor; 2% Nitrification inhibitor. (n=117)
How willing are you to apply/ recommend ESN, nitrification or urease inhibitors to reduce N losses? (Source)	21% Very Willing; 42% Willing; 35% Willing only if cost subsidized. (n=116)
How much more would you be willing to spend to use/recommend Enhanced Efficiency N fertilizers? (Source)	26% no more than now; 62% would spend 10% more; 10% would spend 25% more; 2% would spend 50% more. (n=119)
What rate of N do you use or recommend for your field? (Rate)	63% for yield goal; 14% use up to 5% more than goal; 11% use up to 10% more; 8% use more than 20% (n=125)
The N fertilizer rate you recommend or apply is primarily based on obtaining the highest possible yields rather than the most economical return. (Rate)	8% Strongly Agree; 36% Agree; 35% Disagree; 21% Strongly Disagree (n=129)
What is your main motivation to apply N fertilizer in the <i>fall</i> rather than <i>spring</i> ? (Timing)	67% because field is typically drier and workload balance; 16% don't apply in fall; 14% because fertilizer cheaper. (n=121)
Why do you <i>not</i> choose or recommend banding when it is the BMP for your crop? (Placement)	52% usually band; 32% equipment not available; 14% too slow. (n=120)
I intend or currently use/recommend enhanced efficiency fertilizers (EEF) differently than non-EEF sources by: (Placement)	41% don't do anything differently; 24% use less fertilizer and broadcast (maybe incorporate); 15% broadcast instead of band; 12% leave EEF on soil surface; 6% use less fertilizer. (n=112)