Re-evaluating Phosphorus and Potassium Management for Soybeans

Purpose:

Since 1981 average corn yields have increased by 80%, soybeans by 35%, and winter wheat by 65%. The current OMAFRA fertility recommendations were established a number of years ago when yields were lower. There is concern that the current OMAFRA recommendations do not adequately provide for modern crop yields. The OMAFRA recommendations are also based on the sufficiency approach. The sufficiency approach aims to supply the needs of the current crop by taking into consideration the soil test and the immediate economic return to applied P and K. This approach does not aim to build the soil test to any given value. It is also called the "feed the crop" approach. Another strategy to fertilizer recommendations is to "feed the soil". This method is called the "build and maintain" approach. Building phosphorous and potassium levels in soil represents a significant expense to growers, and can pose economic (ie. land rental) and environmental (phosphorous runoff) risks if soil test values are built excessively high. The sufficiency approach also poses risks because it may not supply adequate nutrients in a year with high yield potential. It also does not allow for a grower to mitigate environmental risks by managing application timing throughout the cropping rotation. Due to the limited amount of data available, this research is being conducted to investigate how starter fertilizer selection (product, rate) and soil fertility management strategy (sufficiency or build and maintain) influence the economics and productivity of corn, soybeans and wheat over the long term in Ontario.

The objectives of this project are to i) identify which fertilizer rates and application methods maximize net returns during the year of application and to ii) identify over the longer term whether meeting fertilizer recommendations for a given fertilizer test will provide yield and net return stability equivalent to a build and maintain approach, particularly in a high yielding environment.

Methods:

Two field scale sites were established in 2012 near Elora and Bornholm. A third site was secured in the fall of the 2013 season near Lucan. One additional site was established by the U of G Ridgetown campus. Each trial location is studying a three crop rotation including winter wheat, soybeans and corn. Table 1, below, outlines the current project timeline, including the years in which the OMAFRA trial locations were established and what crop yield data has been collected.

Trials were positioned on relatively low fertility locations to ensure distinct contrasts can be developed between low and high fertility plots. Four soil fertility treatments have been established to investigate the yield influence of building soil fertility, and include 1) a control (no fertility building), 2) high soil P fertility, 3) high soil K fertility and 4) high soil P and K fertility treatment. Soil P and K are built and maintained by annual applications of 0-46-0 and 0-0-60 as required to build and maintain

Table 1. Timeline for site establishment and crop data collection across OMAFRA sites.

Location	Crops With Data Collected				
	2011	2012	2013	2014	2015
Elora	**Trial established – first broadcast fertilizer app.**	Corn	Corn	Corn	Corn
		Soybeans	Soybeans	Soybeans	Soybean
			Wheat	Wheat	Wheat
Bornholm	**Trial established – first broadcast fertilizer app.**	Corn	Corn	Corn	Corn
		Soybeans	Soybeans	Soybeans	Soybeans
			Wheat	Wheat	Wheat
Lucan			**Trial established – first broadcast fertilizer app.**	Corn	Corn
				Soybeans	Soybean
				Wheat	Wheat

soil test values in a non-responsive range (21 ppm P and 120 ppm K). Starter fertilizers are being investigated by applying treatments ranging from no starter, low rate liquid P and K starter, high rate P, high rate K and high rate P and K starter fertilizers. Yield interactions between soil fertility and starter fertilizer will be analyzed for productivity and economic efficiencies over several years.

The broadcast fertilizer treatments include the following:

1. Control (no broadcast fertilizer)
2. 0-46-0 @ 400 lbs/ac broadcast
3. 0-0-60 @ 400 lbs/ac broadcast
4. 0-46-0 @ 400 lbs/ac broadcast + 0-0-60 @ 400 lbs broadcast

The starter fertilizer treatments include the following:

1. Control (no starter fertilizer)
2. 6-24-6 @ 5 gallons/acre applied in furrow
3. 6-24-6 @ 3 gallons/ac applied in furrow
4. 11-52-0 (MAP) @ 100 lbs/ac applied in a 2x2 band
5. 0-0-60 @ 80 lbs/ac applied in a 2x2 band
6. 6-28-28 @ 90 lbs/ac applied in a 2x2 band
7. 6-28-28 @ 180 lbs/ac applied in a 2x2 band

These treatments were randomized and replicated three times at each trial location. Each treatment was 10’ wide by 60’ long. Trials were planted with a Kearney 15” vacuum planter with a precision seed monitor. . All harvesting was completed utilizing a customized combine equipped with a batch weigh system and moisture tester.

Image1. 15” row unit planter equipped to apply both liquid and dry fertilizer used in 3 of the 4 sites.

Results:

Results from the 2012 season showed there were significant broadcast and starter fertilizer effects at Elora while lesser yield responses were observed at Bornholm to broadcast or starter fertilizer applications. Highest yields were almost always associated with the high P and K soil fertility (broadcast) treatments, specifically at the Elora location.

In 2013 there were significant broadcast and starter fertilizer effects at Elora and Bornholm. In general, significant yield responses appeared to depend on both sufficient P and K fertility, whether provided by high soil fertility (broadcast treatments) or starter fertilizer. Highest yields were almost always associated with the high P and K soil fertility (broadcast) treatments at both locations, suggesting high soil fertility played a role in maximizing soybean yields in 2013. There were no significant yield responses to starter fertilizers under high P and K soil fertility.

In 2014, there was a positive yield response to starter fertilizer application and there was also a response to broadcast fertilizer at all three locations. However, only at the Elora site was the starter fertilizer unable to provide maximum yield in the absence of a broadcast treatment. At the Bornholm and Lucan location full yield potential could be attained in soybeans through either a broadcast treatment or a starter treatment. Potash deficiency symptoms were evident at the Elora site where no fertilizer was applied.

Image2: Potash deficiency symptoms at the Elora site.

Table 2shows the average yield responses to starter and broadcast fertilizer treatments at the various trial locations in 2015. On average there was a positive yield response to starter fertilizer application and there was also a response to broadcast fertilizer at all three locations. At both the Elora and Lucan sites the starter fertilizer treatments were unable to provide maximum yield in the absence of a broadcast treatment. At the Bornholm location full yield potential could be attained in soybeans through either a broadcast or starter treatment.

In general, yield response depended on both P and K being sufficient, whether provided by high soil fertility (broadcast treatments) or starter fertilizer. There was no additional yield to starter fertilizer when both P and K fertilizer was broadcast.

Summary:

1. Highest yields were evident when both phosphorus and potassium fertility were sufficient. These nutrients could be provided by either high soil fertility (broadcast) or as starter fertilizer at the Bornholm location. At the Elora and Lucan locations the starter fertilizer by itself was not able to provide maximum yield when no broadcast fertilizer was applied.
2. The Elora site was highly responsive to K but both P and K were necessary for high yield consistency.
3. There was no yield response to a starter applied in addition to the P and K broadcast treatment (high soil fertility) at any of the sites.
4. The soybean yields to date suggest that the sufficiency approach (starter fertilizer) may not be adequate to attain full yield potential at some sites. An economic analysis will be conducted in future years when the soil test values of the high soil fertility treatments have built to a reasonable level.

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Table 2. Soybean yield response to starter fertilizer and broadcast fertilizer treatments at Elora, Bornholm and Lucan in 2015.

Location*	Starter Fertilizer	Broadcast Fertilizer			
		No Br	Br P	Br K	Br P & K
		---------- *yield (bu/ac)* ----------			
Elora	CONTROL	40	43	42	56
	6-24-6 @ 5 gal/ac (IF)	42	42	47	52
	11-52-0 @ 100lbs/ac (2x2)	40	45	51	58
	0-0-60 @ 80lbs/ac (2x2)	44	48	43	52
	6-28-28 @ 180lbs/ac (2x2)	45	53	49	56
Bornholm	CONTROL	48	50	48	52
	6-24-6 @ 5 gal/ac (IF)	49	54	48	54
	6-24-6 @ 3 gal/ac (IF)	49	54	47	49
	11-52-0 @ 100lbs/ac (2x2)	54	50	49	52
	0-0-60 @ 80lbs/ac (2x2)	51	49	45	48
	6-28-28 @ 90lbs/ac (2x2)	50	50	49	50
	6-28-28 @ 180lbs/ac (2x2)	51	56	51	56
Lucan	CONTROL	55	57	56	61
	6-24-6 @ 5 gal/ac (IF)	56	58	59	63
	6-24-6 @ 3 gal/ac (IF)	56	56	55	63
	11-52-0 @ 100lbs/ac (2x2)	58	61	57	63
	0-0-60 @ 80lbs/ac (2x2)	55	59	52	61
	6-28-28 @ 90lbs/ac (2x2)	56	57	54	59
	6-28-28 @ 180lbs/ac (2x2)	55	60	59	58

*Initial soil test values of the Control treatments at Elora were 11 ppm for P and 57 ppm for K. At Bornholm they were 20 ppm for P and 111 for K. At Lucan they were 11 ppm P and 118 ppm K.

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