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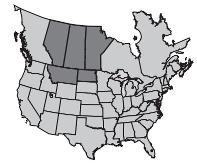
International Plant Nutrition Institute



September 2012

Drought and Nutrient Applications: A Northern Great Plains Perspective

In the Northern Great Plains (NGP) region of North America there is almost always an area that experiences drought in any one year. This is because the region is expansive—going from the southern borders of Montana and North Dakota, north through the agricultural land of Manitoba, Saskatchewan, and Alberta, and further north and west up into northeastern British Columbia. Much of the region is considered semi-arid and would probably be considered arid, even in normal rainfall years, if it wasn't for reduced evapotranspiration from lower temperatures experienced in the cold winters, and cool springs and falls. Total average annual precipitation ranges from a high of 20.2 in. from eastern North Dakota in the Red River Valley, to a low of 12.7 in. around the tri-corner area of northeast Montana, southwest Saskatchewan, and southeast Alberta. The whole region, especially the lower rainfall areas, have historically experienced drought periods that can last for up to 3 or even 5 years. One of the more memorable droughts over the past century occurred from 1933 to 1940 (7 years) in parts of the Great Plains.

In North America during the 2012 crop year, drought has been present in extensive areas of the southwest, Great Plains, and most of the Corn Belt up into northeastern Canada (**Figure 1**). For the NGP region there has been quite severe drought in Montana and parts of North Dakota, but as you go north the moisture conditions have been average, to above average through Manitoba, Saskatchewan, and Alberta, until the Peace River block of northwest Alberta and northeast British Columbia, where dry to droughty conditions have been present (**Figure 2**).

A farmer could decide on the most effective rate of fertilizer nutrients to apply to a spring planted crop, if the following information was known at the time of planting:

- Plant available moisture in the soil
- Levels of plant available nutrients [e.g. nitrogen (N), phosphorus (P), potassium (K), sulfur (S)]
- How much N will be mineralized and made available to the crop from soil organic matter and previous crop residues
- Growing season temperatures
- **Most importantly, how much and when will rainfall be received**

The amount and timing of rainfall is very difficult to predict, and rainfed crop yields are very dependent on growing season moisture. If however the upcoming rainfall amounts and timings were known, the potential yield could be accurately estimated, and the effective rates of fertilizer nutrients required to achieve potential crop yields could be determined. To a certain degree this is done by farmers who have access to irrigation, but even with irrigation sometimes hot dry and windy weather can result in evapotranspiration demands that exceed irrigation capacity for high crop yields.

Most farmers plan for average, to somewhat above average moisture conditions, and apply fertilizer nutrients accordingly. Minor adjustments are often made if spring soil moisture conditions are either somewhat lower or somewhat higher than average. If very dry or even droughty conditions persist from the previous growing season most farmers will apply lower rates of fertilizer nutrients than normal. However, the reduction of fertilizer rates can be excessive, especially if moisture conditions improve early in the rest of the growing season, and inadequate plant available nutrients are present to match the improved crop yield potential.

Adequate fertilizer can help even a moisture deficient crop to yield higher, often with reasonable economic returns. It is useful to observe what effect moderate rates of fertilizer can have on crop yields over a few decades at locations where long-term crop rotation studies have been conducted. One such study, named the ABC Rotation, is at the Agriculture and Agri-Food Canada Research Station near Lethbridge, Alberta. Part of this study has recorded spring wheat yields from 1912 until present.

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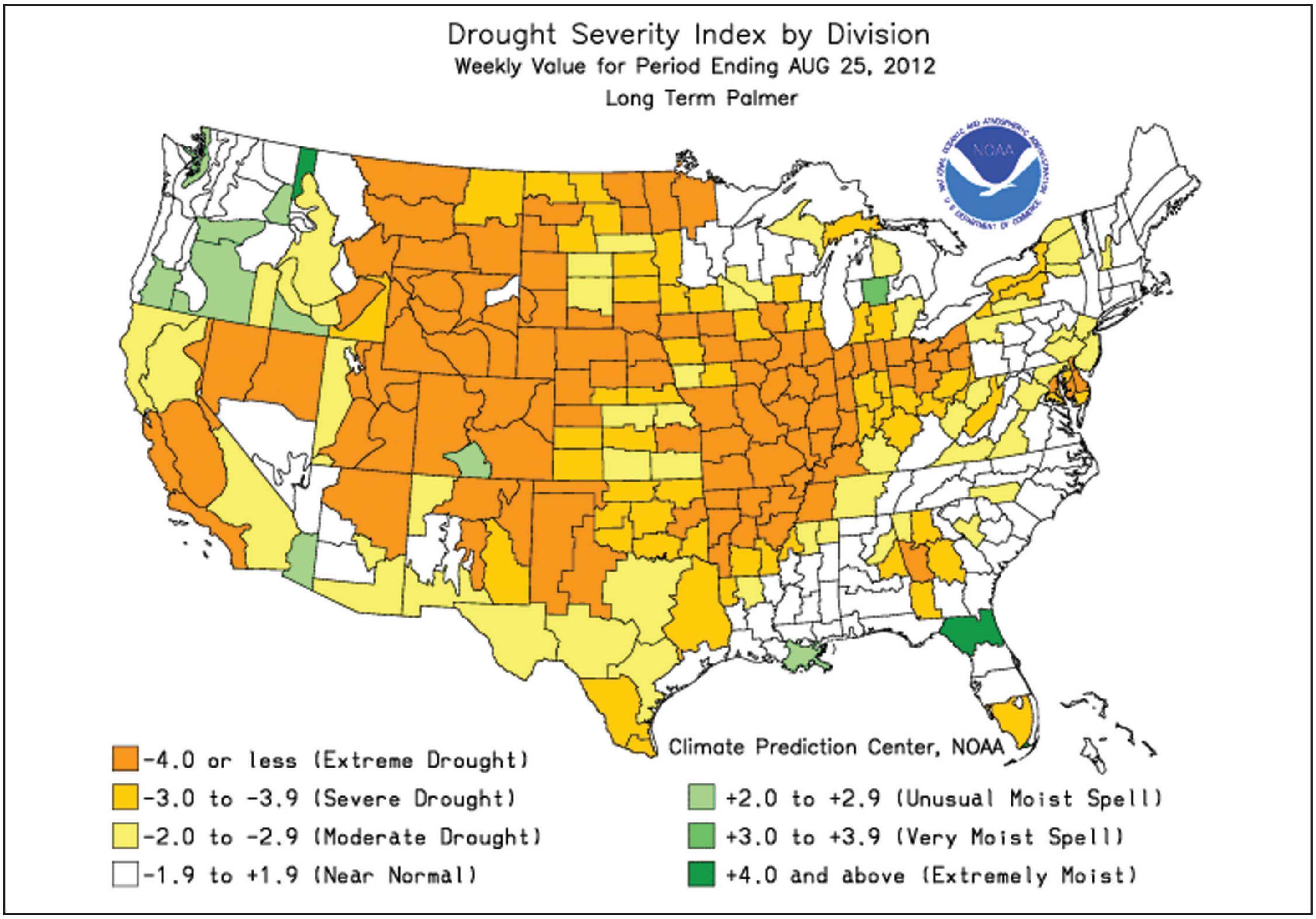

Figure 1. US Drought Severity by Division, Weekly Value for Period Ending Aug 25, 2012, Long Term Palmer Drought Index. http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/palmer.gif

This represents continuously planted spring wheat for one century. With the general use of fertilizer becoming common in the late 1960s, a portion of the original study was separated out and has received N and P fertilizer since 1972, at rates of 40 lb N/A, and 41 lb P_2O_5/A. It is possible to compare wheat yields from the long-term check portion that has received no fertilizer, to the fertilized portion having received N and P at the above noted rates, for 38 years ….1972 through 2010. The average growing season precipitation (April 1 through to August 31) over the 38-year time period has been 9.8 in.

The 38-year average yield of the check, or no fertilizer, treatment has been 20.5 bu/A, compared to fertilized treatment yielding 34.8 bu/A. In **Table 1** below there is comparison of the 38-year average values, to selected years, either wetter or drier than the average. The largest relative yield increase over the check of 111% occurred in the driest year (2000) and resulted in a greater yield response (15.2 bu/A) and a greater increase in net return than the 38-year average.

It is important to note that the fertilizer applications in the long-term study that began in 1972 were probably sub-

Table 1. Spring wheat yields (bu/A) from non-fertilized and fertilized areas, 38-year average, compared to very dry, very moist, a bit lower than average, and dry growing season precipitations.

Year	Growing season precipitation, in.	Check yield	Fertilized yield (40 lb N and 41 lb P_2O_5/A)	Yield increase with fertilizer	% increase over check	Increased net returns (fertilized minus check)*
2002 (very moist)	16.2	26.7	44.4	17.7	66	$104.71
38-year avg.	**9.8**	**20.5**	**34.8**	**14.3**	**70**	**$76.05**
2006 (lower than avg.)	8.5	19.1	39.0	19.9	104	$123.26
2007 (dry)	6.8	16.3	26.9	10.6	65	$44.86
2000 (very dry)	3.9	13.7	28.9	15.2	111	$83.64

*Net returns calculated using 46-0-0 at $567/ton, 11-52-0 at $640/ton, and wheat at $8.43/bu, 29-Aug-2012 western Canada prices.

optimal for N, as most wheat crops in the Lethbridge area under rainfed conditions will now receive applications between 70 and 80 lb N/A; and P_2O_5 applications in the original study are in excess of removals and more commonly are around 20 to 25 lb P_2O_5 in farmer fields. However, farmers will adjust fertilizer applications rates down if moisture conditions appear drier than normal at planting, and adjust fertilizer application rates up if moisture conditions seem greater than normal at planting. This is especially so for N fertilizer, but also P fertilizer to a lesser degree. However, the data in **Table 1** clearly show that fertilizer plays a critical role in dry years and needs to be managed properly following the principles of 4R Nutrient Stewardship (right source at the right rate, right time and right place) just as in more favorable production seasons.

Here are some strategies for farmers experiencing drought conditions for a couple of years in a row:

- It is useful to soil test in the spring prior to planting and if there is above average residual N in the soil, the fertilizer applications rate should be reduced proportionally. For example, under more normal moisture conditions soil-test N can be around 15 lb N/A, and a normal N application is 70 lb N/A, for a total of 85 lb N/A crop available N. However, because of dry to drought conditions the previous year the residual N is 35 lb N/A, and the drought conditions appear to be continuing, a farmer may decide to reduce the combined total pre-plant N to 60, and only apply 25 lb N/A as additional fertilizer.
- If moisture conditions improve early in the growing season after planting, say by the 4-leaf stage of spring wheat, there could be a contingency plan to top-dress with a surface application of urea or UAN. This makes use of moisture received and improves yield potential. For example, a typical top-dressing N application for the Lethbridge area under rainfed conditions could be between 25 and 30 lb N/A.

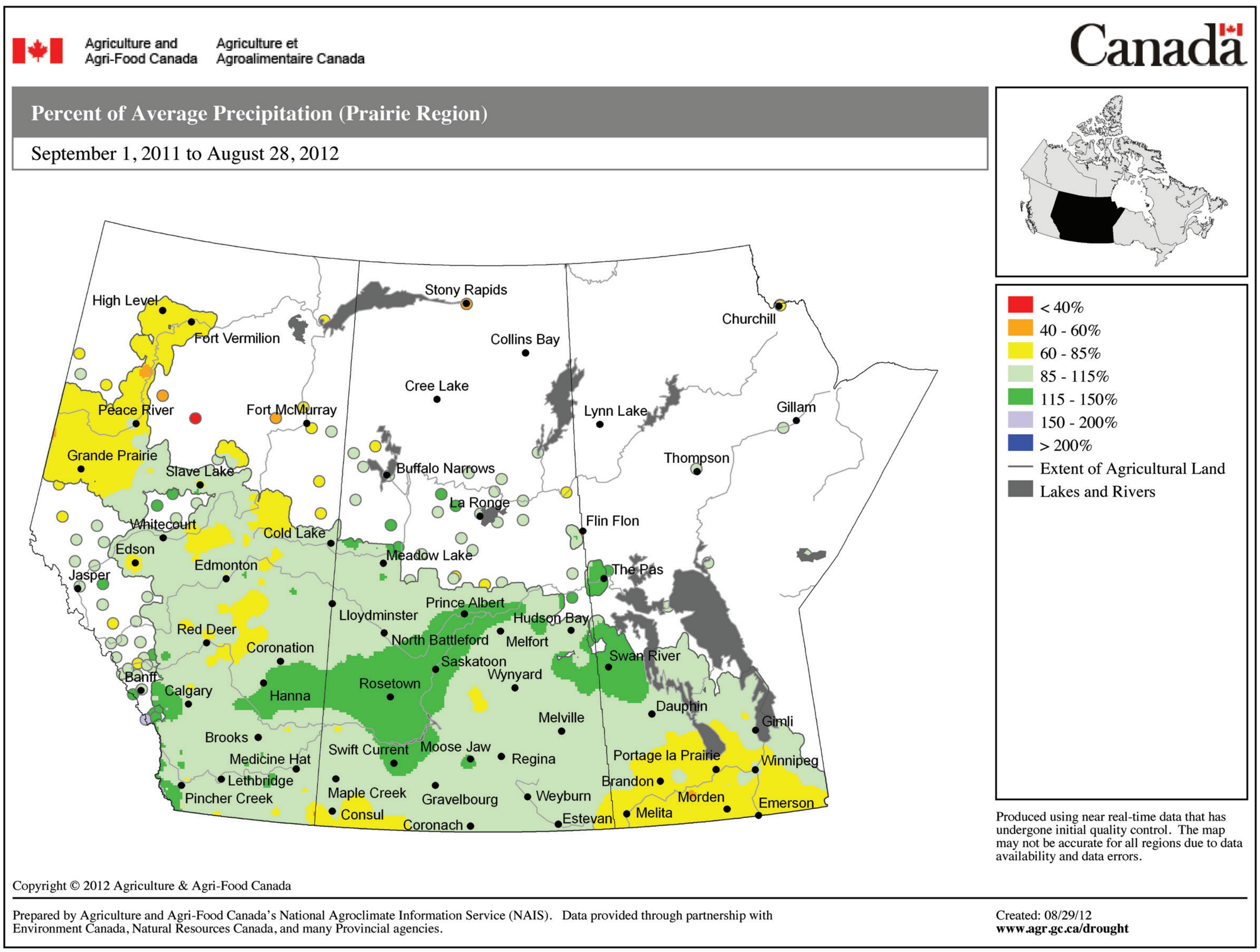

Figure 2. Moisture Conditions, Percent of Normal Amounts, for the Crop Year 2012, Sept. 1, 2011 through to August 27, 2012. http://www4.agr.gc.ca/DW-GS/current-actuelles.jspx?lang=eng&jsEnabled=true

Summary

In summary, dry to drought conditions are common in the NGP. Farmers should consider soil testing and if there is above normal residual plant nutrient levels, primarily N, adjust N fertilizer applications to rates lower than normal based on the soil test results. Additional adjustments in fertilizer rates, either up or down, can be based on the weather in the early part of the growing season. However, cutting back fertilizer rates to zero is usually not wise as even in dry years there is usually a net economic benefit from optimum rates of fertilizer. If rainfall conditions improve early in the growing season, there can be benefits from topdressing additional N. In essence, 4R Nutrient Stewardship is no less important in dry years than in normal years and may in fact make the difference between profit and loss.

Nutrient Deficiency Photo Application for iPhone/iPad Released

IPNI has released a new Crop Nutrient Deficiency Photo Library app for your iPhone or iPad (see http://info.ipni.net/ndapp). The app contains key photos of classic nutrient deficiency documented from research plots and farm fields for 14 common crops. It also provides supporting text and illustrations of nutrient deficiencies. This mobile app will be a great tool for crop advisers, consultants, farmers, and anyone wanting help in identifying nutrient deficiency symptoms in common crops.