NORTHWEST CROPS & SOILS PROGRAM

2015
Organic Spring Wheat Variety Trial

Dr. Heather Darby, UVM Extension Agronomist
Hillary Emick, Lily Calderwood, Erica Cummings, Susan Monahan, Julian Post and Sara Ziegler
UVM Extension Crops and Soils Technicians
(802) 524-6501

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UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2015 ORGANIC SPRING WHEAT VARIETY TRIAL

Dr. Heather Darby, University of Vermont Extension
Heather.Darby[at]uvm.edu

In 2015, the University of Vermont Extension Northwest Crops and Soils Program evaluated twelve hard red spring wheat to determine which varieties thrive in organic production systems. The trial was established at the Borderview Research Farm in Alburgh, Vermont. Several varieties that did not perform well in previous trial years were eliminated from the 2015 variety trial. Newly released varieties were also sought for evaluation.

MATERIALS AND METHODS

The experimental plot design was a randomized complete block with four replications. Spring wheat varieties evaluated and their sources are listed in Table 1.

Table 1. Twelve spring wheat varieties trialed in Alburgh, VT.

Spring wheat varieties	Type	Origin and release year	Seed source
AC Walton	HR	AAFC, PEI, 1995	2012 saved trial seed, VT
Faller	HR	NDAES, 2007	Albert Lea Seed House, MN
Forefront	HR	SDAES, 2012	South Dakota State University, SD
Glenn	HR	NDAES, 2005	Albert Lea Seed, MN
Magog	HR	Semican Inc.	Semican Atlantic Inc., Canada
Prevail	HR	SDAES, 2014	South Dakota State University, SD
Prosper	HR	NDAES & MAES, 2012	Albert Lea Seed, MN
RB07	HR	MAES, 2007	Minnesota Foundation Seed
Sy Rowyn	HR	Syngenta Seeds Inc., 2013	2013 saved trial seed, VT
Sy Soren	HR	Agripro Syngenta, 2011	Albert Lea Seed House, MN
Tom	HR	MAES, 2008	2012 saved trial seed, VT
Yorkton	HR	Western Canada, 2013	Semican, Canada

Abbreviations: AAFC = Agriculture and Agri-Food Canada, HR = hard red wheat, MAES = Minnesota Agricultural Experiment Station, NDAES = North Dakota Agricultural Experiment Station, NPSAS = Northern Plains Sustainable Agriculture Society, PEI = Prince Edward Island, SDAES = South Dakota Agricultural Experiment Station, NDSU = North Dakota State University.

The seedbed at the Alburgh location was prepared by conventional tillage methods. All plots were managed with practices similar to those used by producers in the surrounding areas (Table 2). The previous crop planted at the site was a forage summer annual. In April 2015, the field was disked and spike tooth harrowed to prepare for planting. The plots were seeded with a Great Plains NT60 Cone Seeder on 19-Apr at a seeding rate of 125 lbs ac^{-1} (Image 1). Plot size was 5'x 20'.

Table 2. General plot management of the spring wheat trial, 2015.

Trial Information	Spring wheat variety trial
Location	Borderview Research Farm Alburgh, VT
Soil type	Benson rocky silt loam
Previous crop	Summer annuals
Row spacing (in)	6
Seeding rate (lbs ac^{-1})	125
Replicates	4
Planting date	19-Apr
Harvest date	3-Aug
Harvest area (ft)	5 x 20
Tillage operations	Fall plow, spring disk & spike tooth harrow

In May, wheat populations were determined by taking three one-foot counts per plot. Flowering dates of the wheat were recorded when at least 50% of the spikes were in bloom. Throughout the growing season, other pertinent observations such as disease and wheat development were recorded. Disease incidence was noted.

Grain plots were harvested with an Almaco SPC50 plot combine on 3-Aug, the harvest area was 5' x 20' (Image 2). Prior to harvest, plant heights were measured excluding the awns. A visual estimate of the percentage of lodged plants and the severity of lodging was recorded based on a visual rating with a 0 – 5 scale, where 0 indicates no lodging and 5 indicates severe lodging and a complete crop loss. In addition, grain moisture, test weight, and yield were calculated.

Image 1. Seeding spring wheat variety trial, Alburgh, VT, 2015.

Following harvest, seed was cleaned with a small Clipper cleaner (A.T. Ferrell, Bluffton, IN). An approximate one pound subsample was collected to determine quality. Quality measurements included standard testing parameters used by commercial mills. Test weight was measured by the weighing of a known volume of grain. Generally the heavier the wheat is per bushel, the higher baking quality. The acceptable test weight for bread wheat is 56-60 lbs per bushel. Once test weight was determined, the samples were then ground into flour using the Perten LM3100 Laboratory Mill. At this time flour was evaluated for its protein content, falling number, and mycotoxin levels. Grains were analyzed for protein content using

Image 2. Spring wheat variety trial harvest, Alburgh, VT.

the Perten Inframatic 8600 Flour Analyzer. Grain protein affects gluten strength and loaf volume. Most commercial mills target 12-15% protein. Protein was calculated on a 12% moisture and 14% moisture basis. The determination of falling number (AACC Method 56-81B, AACC Intl., 2000) was measured on the Perten FN 1500 Falling Number Machine. The falling number is related to the level of sprout damage that has occurred in the grain. It is measured by the time it takes, in seconds, for a stirrer to fall through a slurry of flour and water to the bottom of the tube. Falling numbers greater than 350 indicate low enzymatic activity and sound quality wheat. A falling number lower than 200 indicates high enzymatic activity and poor quality wheat. Deoxynivalenol (DON) analysis was analyzed using Veratox DON 5/5 Quantitative test from the NEOGEN Corp. This test has a detection range of 0.5 to 5 ppm. Samples with DON values greater than 1 ppm are considered unsuitable for human consumption.

All data was analyzed using a mixed model analysis where replicates were considered random effects. The LSD procedure was used to separate cultivar means when the F-test was significant ($P< 0.10$). There were significant differences among the two locations for most parameters and therefore data from each location is reported independently.

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among varieties is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (e.g. yield). Least Significant Differences at the 10% level of probability are shown. Where the difference between two varieties within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure in 9 out of 10 chances that there is a real difference between the two varieties. In the example below, variety A is significantly different from variety C, but not from variety B. The difference between A and B is equal to 725, which is less than the LSD value of 889. This means that these varieties did not differ in yield. The difference between A and C is equal to 1454, which is greater than the LSD value of 889. This means that the yields of these varieties were significantly different from one another. The asterisk indicates that variety B was not significantly lower than the top yielding variety.

Variety	Yield
A	3161
B	3886*
C	**4615***
LSD	**889**

RESULTS AND DISCUSSION

Seasonal precipitation and temperature recorded at Borderview Research Farm in Alburgh are displayed in Table 3. The growing season this year was marked by lower than normal temperatures in April and June and higher than average temperatures in May. There was lower than normal rainfall throughout the growing season (Apr-June) with the exception of heavy rain in June. From April to July, there was an accumulation of 3408 Growing Degree Days (GDDs) in Alburgh, which is 56 GDDs above the 30 year average.

Table 3. Temperature and precipitation summary for Alburgh, VT, 2015.

Alburgh, VT	April	May	June	July
Average temperature (°F)	43.4	61.9	63.1	70.0
Departure from normal	-1.4	5.5	-2.7	-0.6
Precipitation (inches)	0.09	1.94	6.42	1.45
Departure from normal	-2.73	-1.51	2.73	-2.70
Growing Degree Days (base 32°F)	352	930	938	1188
Departure from normal	-32	174	-76	-10

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Spring Wheat Growth and Development:

During the 2015 growing season, several observations and measurements were recorded on spring wheat development. All varieties were in full bloom by 24-Jun. There was minimal bird damage and no lodging was observed (data not shown). In general, there was less disease and greater insect damage observed than in previous years.

Thrips are small insects with fringed wings that feed on a variety of plants by puncturing the cells and sucking up the contents. Damage caused by thrips includes discoloration and leaf scarring reduced growth of the plant, and they can also act as a disease vector. Thrips were observed on all varieties and in more than 75% of plots.

Mites were observed on eleven out of twelve varieties. Mites were not observed on the variety AC Walton. Mites are very small arthopods that feed on the sap of leaves of wheat and other grain crops. Leaves affected by mites may appear yellowish or silvery in early stages of infestation and later take on a scorched appearance. Injury caused by mites can result in stunted plants.

Cereal leaf beetles were observed on four varieties including Forefront, Glenn, Magog and Sy Rowyn. Cereal leaf beetle is an invasive species native to Europe that was accidentally introduced to the U.S. in the 1960's. The larvae of the beetle can cause significant damage to grain crops.

Foliar diseases reduce photosynthetic leaf area, use nutrients, and increase respiration and transpiration within colonized host tissues. The diseased plant typically exhibits reduced vigor, growth and seed fill. The earlier occurrence, greater degree of host susceptibility, and longer duration of conditions favorable for disease development will increase the yield loss. In previous years, several foliar diseases were observed during wheat development, including powdery mildew (*Erysiphe graminis f. sp. Tritici*) and loose smut (caused by the fungus *Ustilago tritici*). Loose smut and powdery mildew were not observed on any varieties in the 2015 trials. Tan spot is a foliar disease caused by the fungus *Pyrenophora tritici-repentis*. Tan spot can reduce both yield and test weight. Tan spot was observed on seven of the twelve varieties: AC Walton, Magog, Prevail, Sy Rowyn, Sy Soren, Tom and Yorkton.

In the Northeast, *Fusarium* head blight (FHB) is predominantly caused by the species *Fusarium graminearum*. This disease is very destructive and causes yield loss, low test weights, low seed germination and contamination of grain with mycotoxins. A vomitoxin called deoxynivalenol (DON) is considered the primary mycotoxin associated with FHB. The spores are usually transported by air currents and can infect plants at flowering through grain fill. Eating contaminated grain greater than 1ppm poses a health risk to both humans and livestock. In the 2014 trial, thirteen of the 19 varieties displayed bleached grain heads which is associated with the presence of *Fusarium* head blight. Bleached heads were not observed in any varieties in the 2015 trial. However, DON levels (Table 6, Figure 3) were not lower than in previous years.

Plant populations were significantly different between varieties (Table 4). The variety with the highest plant population per square meter was RB07, 379 m^2, and Sy Rowyn had the lowest plant population at 258 m^2. Plant heights were significantly different among varieties. The mean plant height was 29.7 inches. The Yorkton variety was the tallest variety measuring 35.6 inches. Other tall varieties included: Magog (35.5 in.), AC Walton (33.6 in.), and Tom (32.0 in.). Many organic farmers prefer to grow varieties that are tall as they generally have better weed suppressive capabilities.

Table 4. Plant populations and heights of the 12 spring wheat varieties trialed, Alburgh, VT, 2015

Variety	Plant population	Plant height
	m^2	inches
AC Walton	291*	33.6*
Faller	285*	26.3
Forefront	328*	28.2
Glenn	307*	30.0
Magog	355*	35.5*
Prevail	294*	27.9
RB07	**379**	26.1
Prosper	278	29.0
Sy Rowyn	258	27.3
Sy Soren	307*	25.4
Tom	309*	32.0*
Yorkton	264	**35.6**
LSD (0.10)	94	3.72
Trial Mean	305	29.7

<u>Spring Wheat Yields and Quality</u>:

Varieties differed significantly in yield and quality (Table 5 and 6). The mean yield was 1253 lbs ac^{-1}. The 2015 yields were lower than in previous years of the variety trial. (Figure 1).

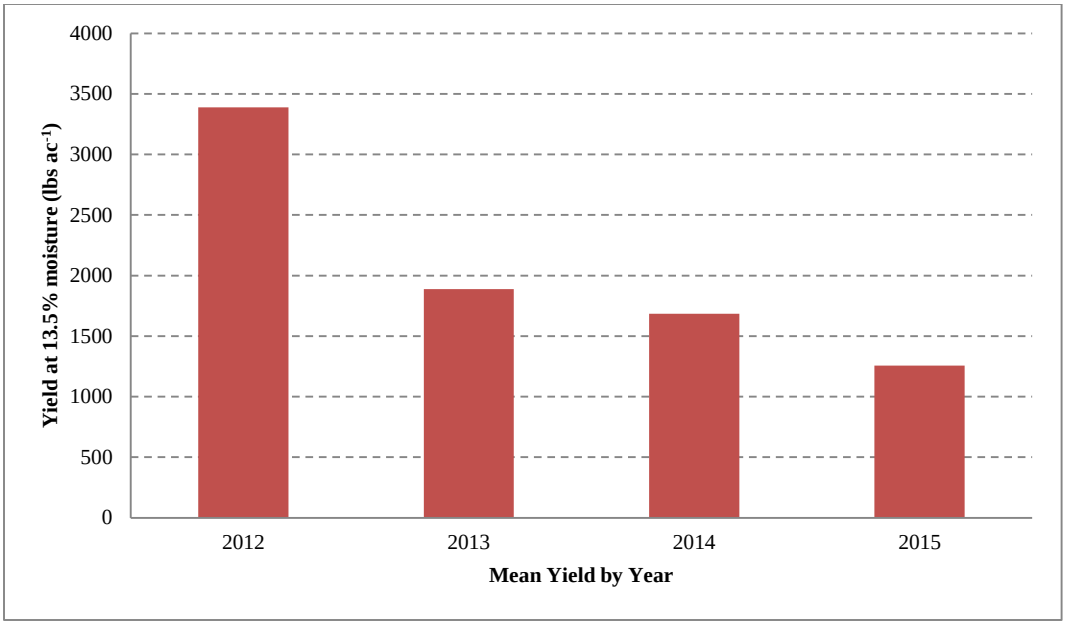

Figure 1. Spring wheat variety trials mean yield comparison for 2012-2015, Alburgh, VT.

The highest yielding variety was AC Walton (1841 lbs ac^{-1}) (Table 5 and Figure 2). Other top yielding varieties include Magog and Tom. The lowest yielding variety was RB07 (829 lbs ac^{-1}). The variety with the lowest moisture at the time of harvest was Magog (10.6%). All varieties had reached an optimal grain storage moisture of 14% or less by harvest.

Table 5. Harvest data of the 12 spring wheat varieties, Alburgh, VT.

Variety	Yield @13.5% moisture	Harvest moisture	Test weight
	lbs ac^{-1}	%	lbs bu^{-1}
AC Walton	**1841**	12.6	55.8
Faller	933	11.6*	58.1
Forefront	958	12.6	57.5
Glenn	1099	11.0*	58.9*
Magog	1670*	**10.6**	58.0
Prevail	1163	11.0*	58.4
RB07	829	11.3*	59.3*
Prosper	1265	13.5	57.8
Sy Rowyn	1160	12.7	57.3
Sy Soren	1235	11.1*	58.9*
Tom	1599*	12.7	**60.1**
Yorkton	1323	10.9*	56.9
LSD (0.10)	314	1.8	1.27
Trial Mean	1253	11.8	58.1

Table 6. Quality results of the 12 spring wheat varieties, Alburgh, VT.

Variety	Crude protein @ 12% moisture	Crude protein @ 14% moisture	Falling number @ 14% moisture	DON
	%	%	seconds	ppm
AC Walton	11.9	11.6	312*	2.10*
Faller	11.0	10.8	328*	2.55*
Forefront	12.9*	12.8*	**352**	2.20*
Glenn	11.6	11.3	325*	2.50*
Magog	12.1*	11.8	293*	3.23
Prevail	**13.4**	**13.3**	286	2.20*
RB07	12.8*	12.6*	332*	2.28*
Prosper	11.5	11.2	294*	2.43*
Sy Rowyn	12.4*	12.1*	291*	3.30
Sy Soren	11.5	11.3	327*	**1.83**
Tom	12.2*	11.9*	272	2.78*
Yorkton	12.1*	11.8	295*	2.98
LSD (0.10)	1.39	0.70	63.3	0.97
Trial Mean	12.1	11.9	309	2.53

Values shown in **bold** are of the highest value or top performing.

* Wheat varieties that are not significantly different than the top performing variety in a column are indicated with an asterisk.

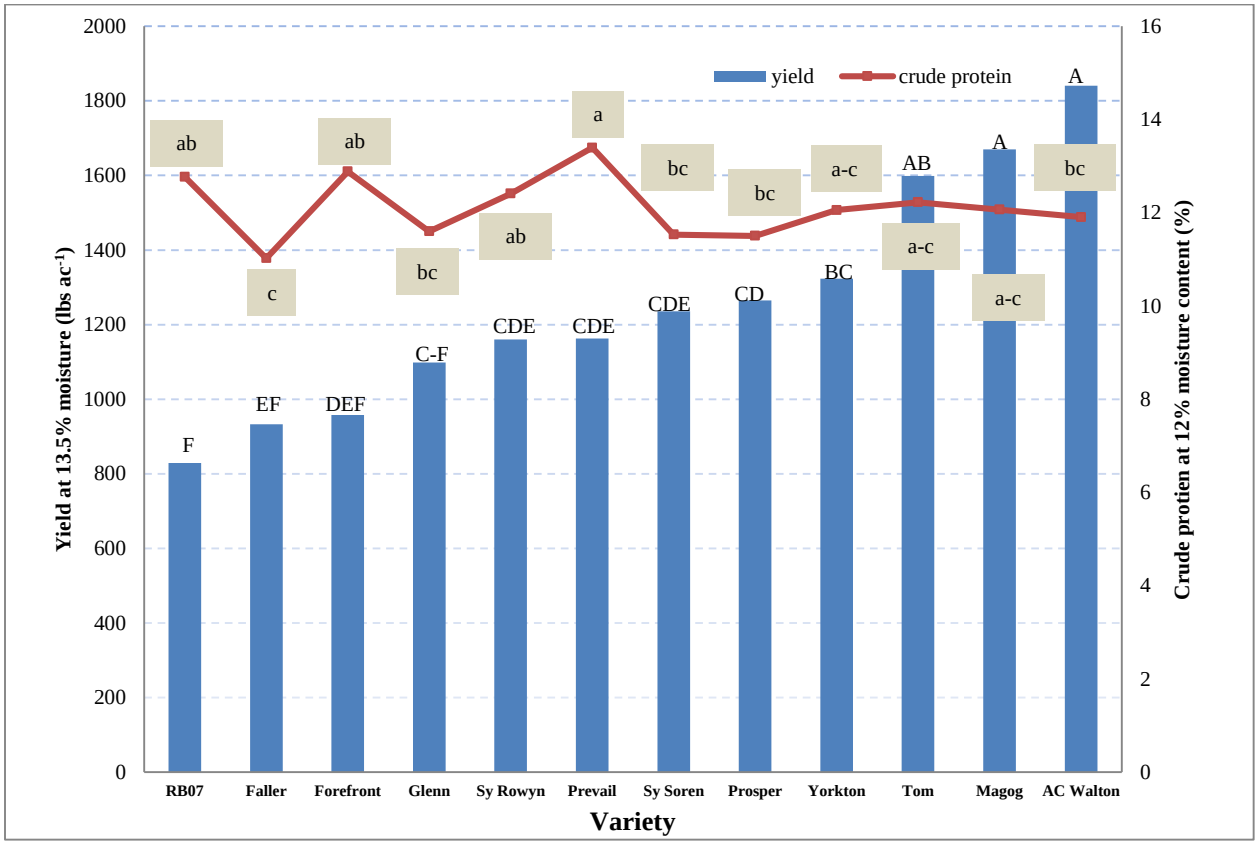

Figure 2. Yield and protein concentrations of 12 spring wheat varieties, Alburgh, VT.
Varieties with the same letter did not differ significantly.

The common measures used by commercial mills to evaluate wheat quality are: grain protein, falling number, test weight, and mycotoxin (DON) content. The variety with the highest protein content was Prevail (13.4% at 12% moisture) (Table 6 and Figure 2). Six other varieties (Forefront, RB07, Sy Rowan, Tom, Magog, and Yorkton) had protein levels that met or exceeded industry standards of 12-14%. The highest yield variety AC Walton was just below this standard at 11.9%. All twelve varieties trialed had falling numbers that were above 250 seconds. The highest falling number was Forefront (352 seconds) and the lowest was Tom (272 seconds). The variety Tom had the highest test weight of 60.1 lbs bu^{-1}. The varieties Glenn, RB07, and Sy Soren had statistically similar test weight. While AC Walton had the highest yield, it was the only one of the 12 spring wheat varieties trialed that did not reach the optimal 56 to 60 lb bu^{-1} test weight for wheat. All of the spring wheat varieties trialed were above the FDA's 1ppm DON limit (Table 6; Figure 3). The lowest DON level in Alburgh was Sy Soren (1.83 ppm).

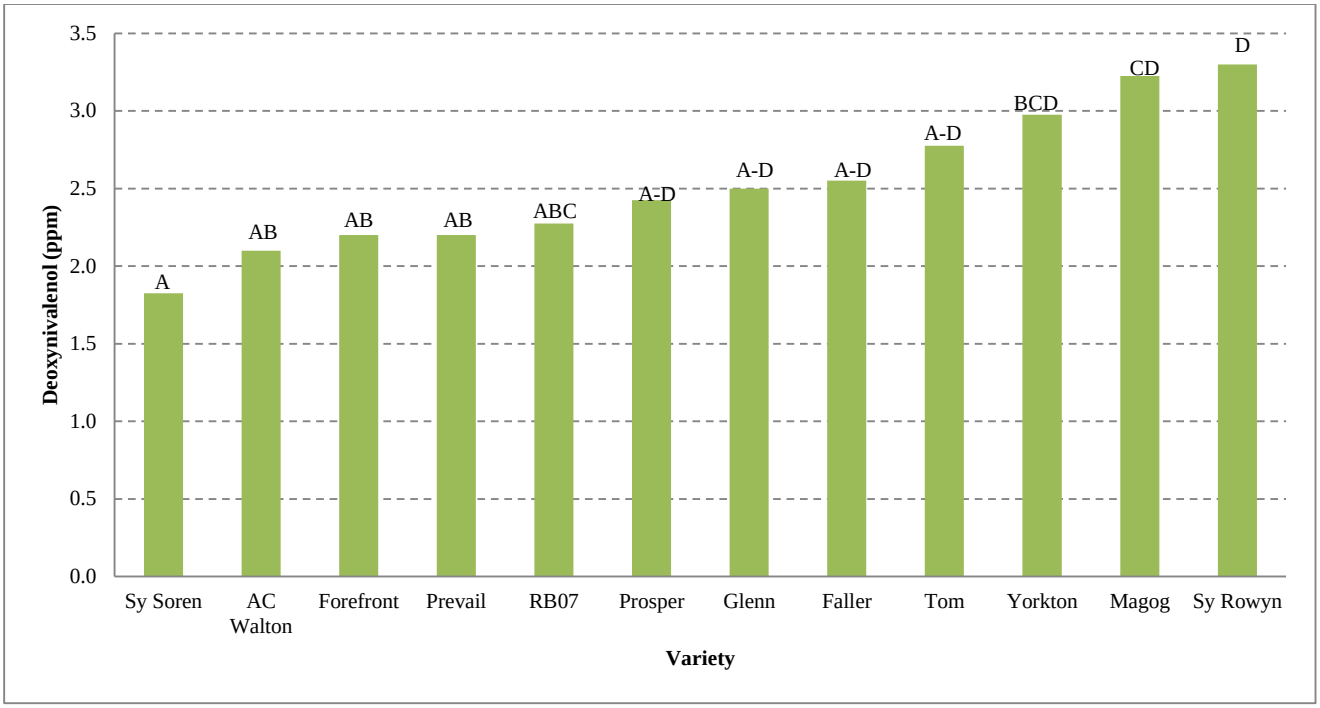

Figure 3. Deoxynivalenol (DON) concentrations of 12 spring wheat varieties, Alburgh, VT.
Varieties with the same letter did not differ significantly.

It is important to remember that the results only represent one year of data. 2015 was another challenging growing season. The high variability in the weather, with cooler and wetter than normal conditions in June and hotter and drier than normal conditions through the rest of the growing season, resulted in reduced yields compared to previous years. Although weather conditions have varied across years, from a cold, wet summer in 2014 and a largely hot and dry summer in 2015, the variety AC Walton has consistently performed at the top of the trial in terms of yield. It is important, as you make variety choices on your farm, that you evaluate data from test sites that are as similar to your region as possible.

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