Seasonal Corn Nutrient Concentration and Uptake in the Mid-Atlantic USA

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Introduction

Periodic assessment of corn (Zea mays L.) nutrient uptake and utilization is necessary to ensure high yields and efficient fertilizer use. Excess fertilizer applied to crops can be lost to the environment so judicious use is important. In environmentally sensitive areas, including the Chesapeake Bay watershed, scrutiny of nutrient inputs, including nitrogen (N) and phosphorus (P) has increased and so while corn yields have risen, fertilizer input recommendations have generally not. Modern corn hybrids are producing greater yields under stress and many are maintaining green leaf area later in the season than older hybrids. These evolutions in corn productions could all result in potential nutrient deficiencies in corn fields.

Objective

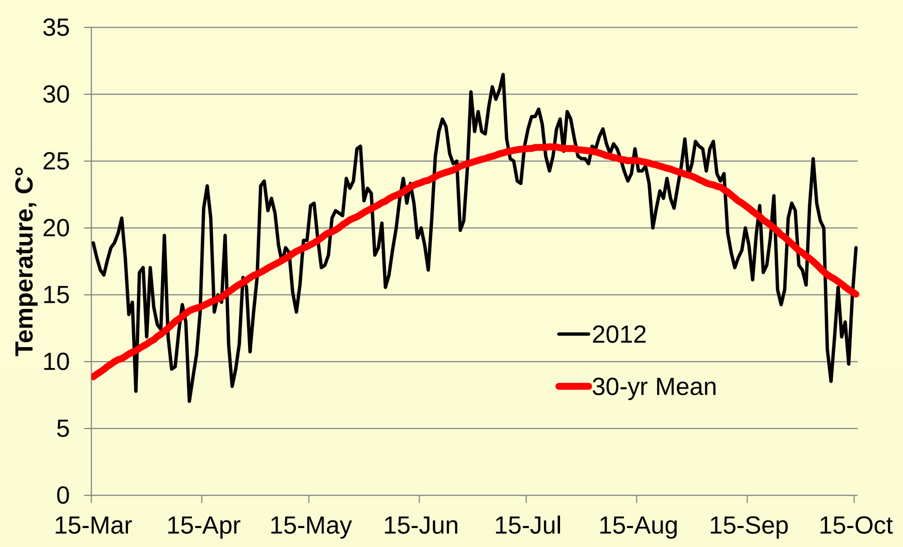
- Assess the range in nutrient concentration and uptake for corn grown in Virginia at various stages of development and link this to grain or silage yield.

Materials and Methods

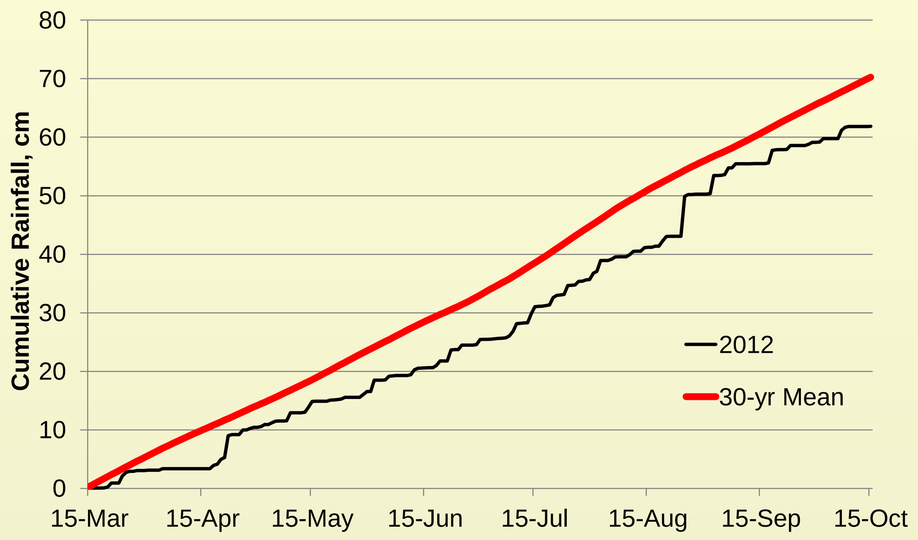
- Fields selected for high to moderately high yield potential from throughout the Commonwealth of Virginia were selected for study.
- Fields and study areas within fields were chosen soon after corn emergence with the intention of including the major soil types and corn growing regions in Virginia
- Prior to the first tissue sampling, composite soil samples were collected from each site in increments of 0-15, 15-30, 30-60 and 60-90 cm taking care to avoid starter fertilizer bands.
- Soil samples were air dried, ground to pass a 2mm sieve and analyzed for carbon (C) and nitrogen (N) via dry combustion with a Vario MAX CN analyzer. A portion of the 0-15 cm sample was submitted to the Virginia Tech soil testing laboratory for routine analysis
- Samples were also extracted using 2 M KCl and analyzed colormetrically for ammonium (NH_4) and nitrate (NO_3) with a Lachat QuickChem Automated Ion Analyzer
- All fields were planted in 76 cm rows; at the V4 and V12 sampling times, all plants in 5.3 m of row were counted in five random locations from the sampling area to estimate plant population
- Fields were sampled at V4, V8, V12, VT, 3-weeks post silking, and black layer (maturity)
- At each sampling time, twenty representative plants were cut at the soil level and weighed. At V4 only data for whole plants were collected, but for subsequent sampling, data were collected by plant part (leaf, stem, spike) by separating and weighing each component separately after total weight was collected
- At blacklayer, in addition to separating into plant parts, grain was shelled, weighed, and grain moisture determined using a dickey-John GAC 2100 (dickey-John, Auburn, IL)
- Tissue N concentration was determined via dry combustion while sulfur, phosphorus, potassium magnesium, calcium, sodium, boron, zinc, manganese, iron, copper and aluminum in tissue samples were measured by ICP-AES after microwave digestion using concentrated HNO_3+H_2O_2
- Nutrient uptake values were calculated as the product of dry matter biomass and nutrient concentration
- Additionally, the most recently mature leaf (V8 and V12) or the ear leaf (VT) was collected from 20 separate plants to provide comparison of the tissue concentration in normally sampled plant part for evaluation at those sampling times

Summary and Results

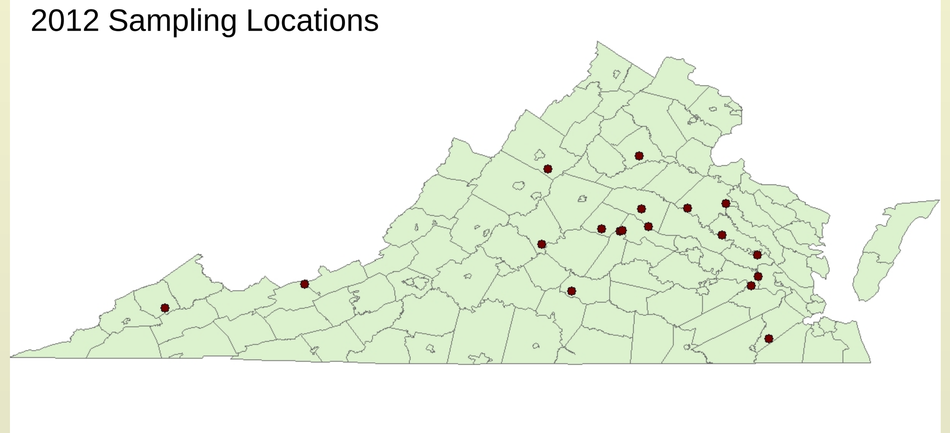
2012 and 30 year mean average daily temperatures for Virginia



2012 and 30 year cumulative rainfall for Virginia

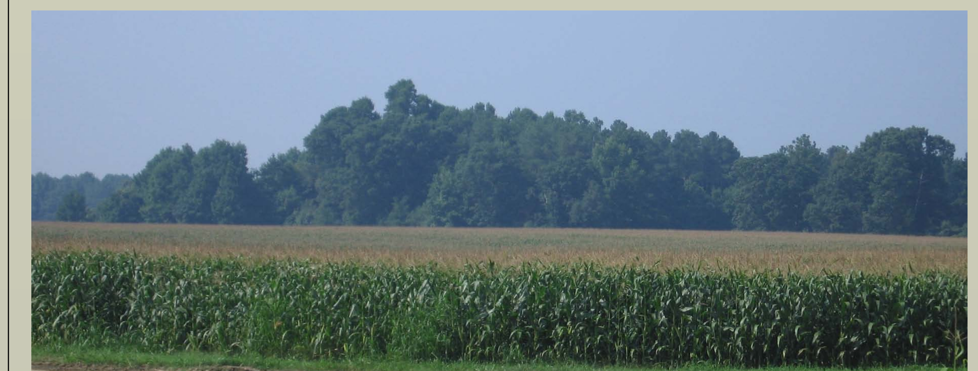


2012 Sampling Locations

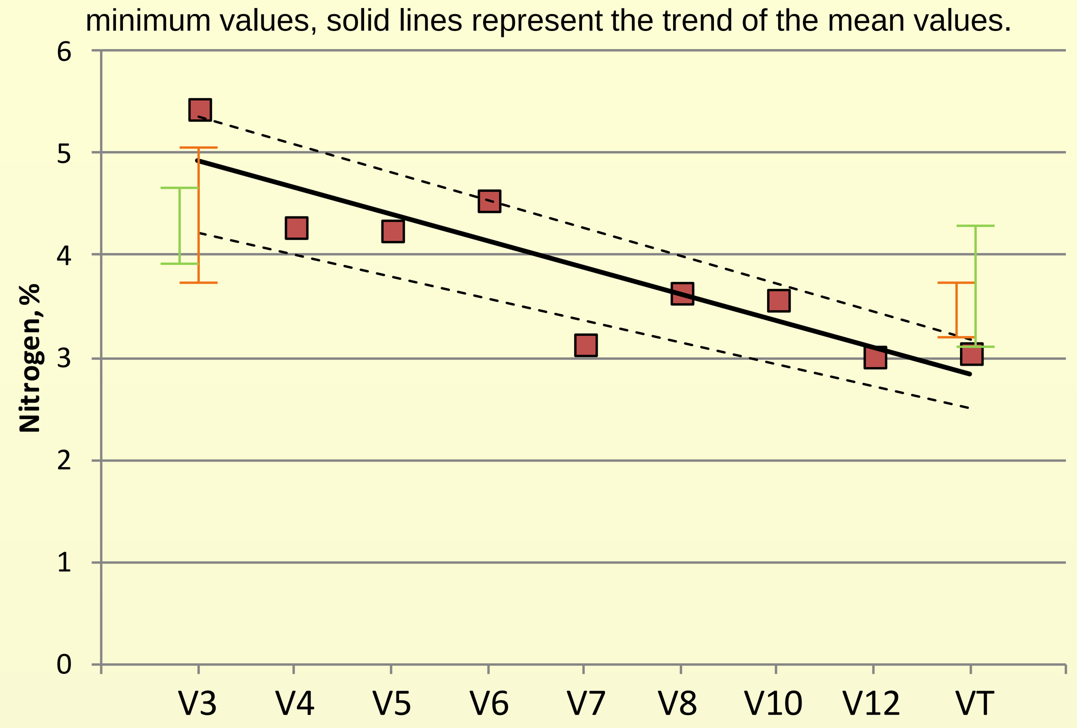


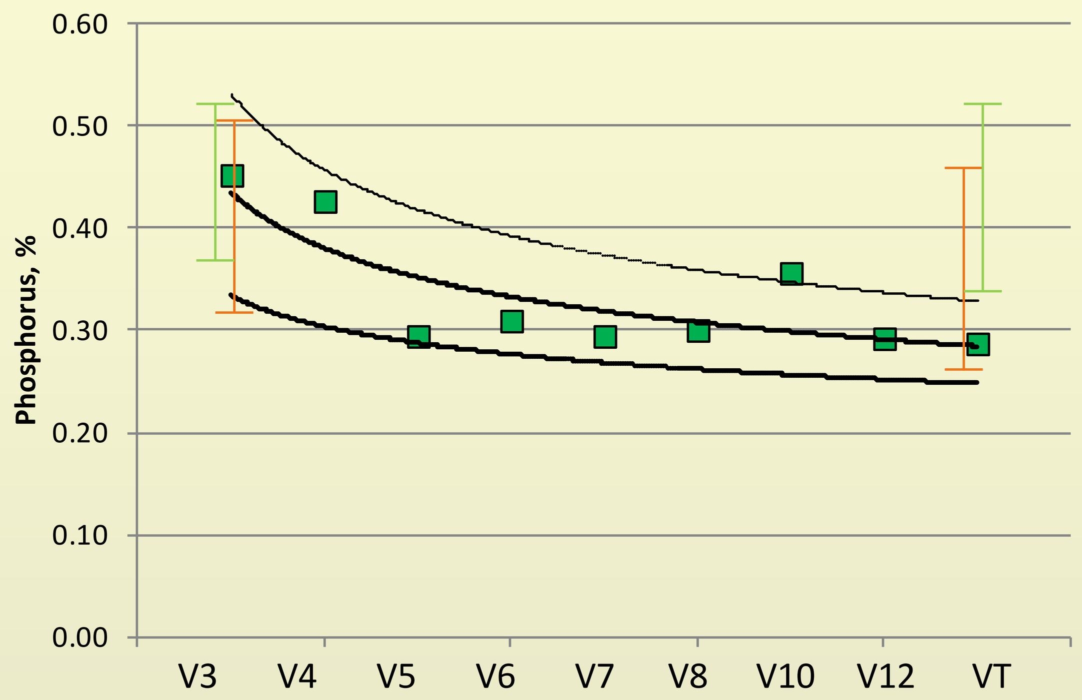
Sampling date and population by sampling site for the uptake sampling sites

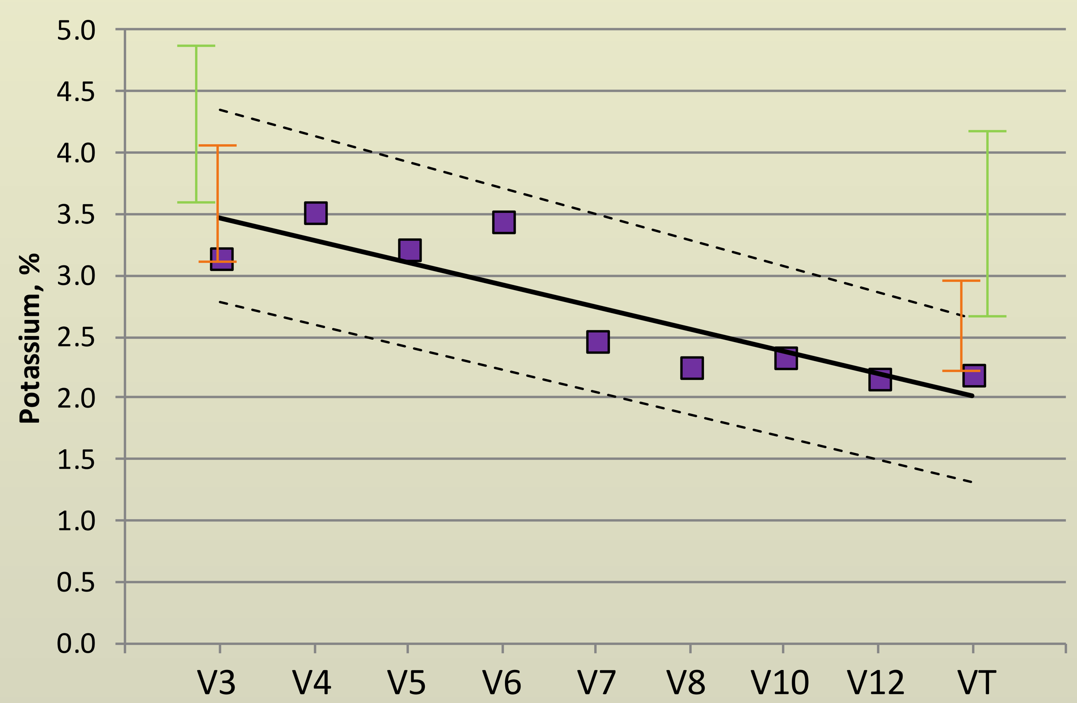
		Sampling Date					
Site	Plants ha^{-1}	V4	V8	V12	VT	R6	Post maturity
1	82251	22-May	na	20-Jun	10-Jul	1-Aug	23-Aug
2	56810	1-Jun	20-Jun	27-Jun	2-Jul	23-Jul	23-Aug
3	76817	1-Jun	20-Jun	27-Jun	17-Jul	1-Aug	23-Aug
4	92131	1-Jun	20-Jun	27-Jun	2-Jul	23-Jul	23-Aug
5	77311	21-May	6-Jun	20-Jun	27-Jun	17-Jul	23-Aug
6	77311	25-Jun	9-Jul	31-Jul	14-Aug	12-Sep	5-Oct
7	84968	22-May	5-Jun	26-Jun	2-Jul	23-Jul	23-Aug
8	82004	21-May	5-Jun	19-Jun	25-Jun	17-Jul	23-Aug
9	75335	21-May	6-Jun	20-Jun	27-Jun	17-Jul	23-Aug
10	74347	13-Jun	26-Jun	2-Jul	17-Jul	6-Aug	14-Sep
11	97812	13-Jun	26-Jun	2-Jul	17-Jul	6-Aug	14-Sep



Corn tissue nutrient concentration over locations at the V3 through VT growth stages. Upper dashed lines represent the trend of the maximum values, lower dashed lines represent the trend of the minimum values, solid lines represent the trend of the mean values.

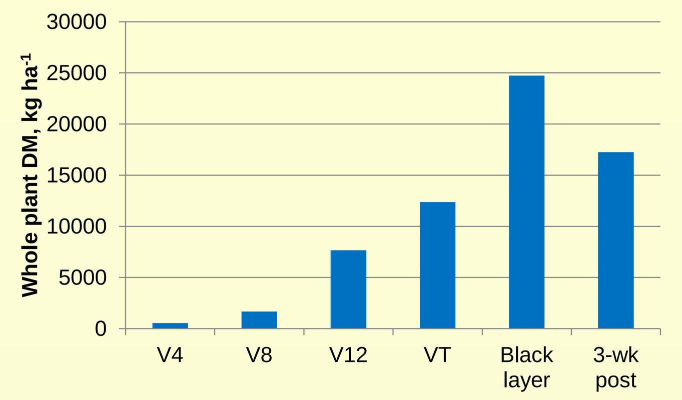




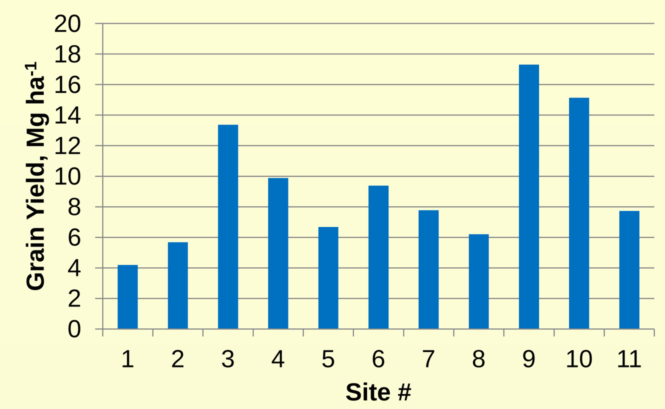


Orange bars represent the recommended range per Virginia
Green bars represent suggested range per A&L Eastern Labs
Separate thresholds exist for V2-V3 and V4-VT

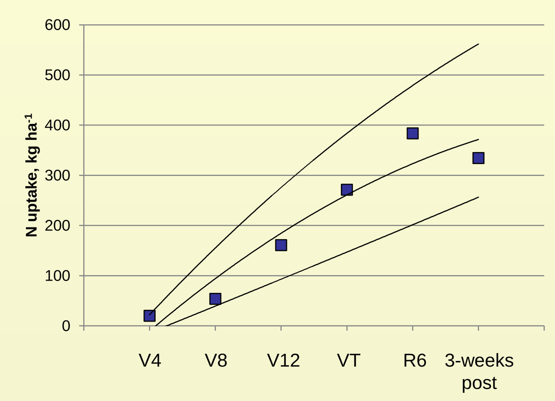
Over locations, whole plant biomass

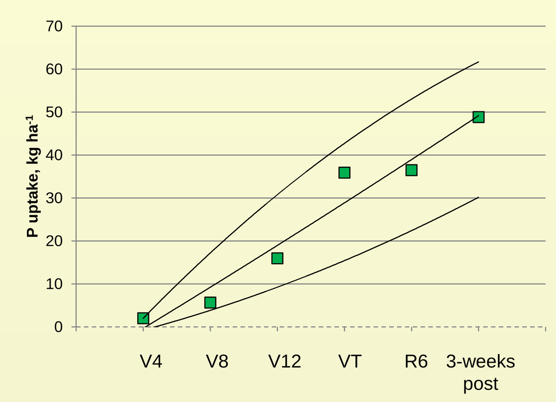


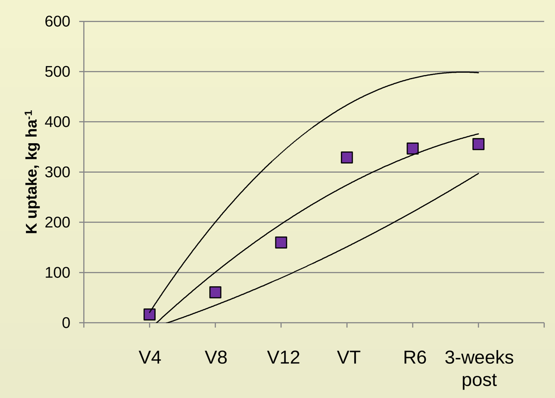
Corn Grain Yield, by location, 2012

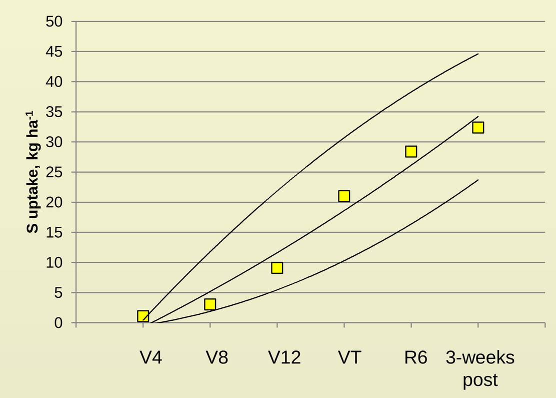


Corn tissue nutrient uptake over locations at the V4 through three weeks post black layer; upper dashed lines represent the trend of the maximum values, lower dashed lines represent the trend of the minimum values, solid lines represent the trend of the mean values.









Conclusions

- The summer of 2012 was abnormally hot in late June and early July. Corn yield potential was reduced by the extreme weather. Cumulative rainfall was below the 30-year average for the entire growing season.
- Concentration of N, P, K, and S declined as plants grew through the season, as expected.
- Early season nutrient concentration measured in these samples was generally within the range recommended by both Virginia Tech and A&L Eastern Labs.
- Late season whole plant nutrient concentration in these samples was at the low end of the recommended ranges recommended by both Virginia Tech and A&L Eastern Labs.
- Over locations, whole plant biomass peaked at physiological maturity at over 20 Mg ha^{-1} and fell by 4 Mg ha^{-1} at three weeks post maturity.
- Similarly, N uptake peaked at physiological maturity, though we observed that P uptake continued to increase at three weeks post maturity.
- Grain yield varied from approximately 4 to 17 Mg ha^{-1} over sites in 2012. This reflects the impact of drought and heat that was experienced to various degrees among the experimental sites.