

## Are Nutrient Deficiencies Limiting High Yield? Tissue and Soil Analyses of North Carolina Corn Yield Contest Entries.

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### Introduction

- Some NC corn growers think nutrient deficiencies are limiting yield, especially under irrigation.
- They question whether [NC Dept. of Agriculture and Consumer Services \(NCDA&CS\) fertilizer recommendations](#) are adequate for today's high-yielding hybrids and management.
- In 2016, 839 corn samples were submitted to NCDA&CS: 42% were judged low or deficient in P, 39% low or deficient in N, 27% low or deficient in B, 26% low or deficient in Mg, and 25% low or deficient in Zn. Of course, this may not have been due to soil insufficiency...
- While NC Corn Yield Contest leaders have attained 18.8 to 21.9 Mg ha<sup>-1</sup>, recent world-record yields, **31.6 Mg ha<sup>-1</sup> in Georgia** and **33.4 Mg ha<sup>-1</sup> in Virginia**, were in environments and soils similar to some of ours, hence NC yield potential is similarly high.
- Researchers have achieved > 13 Mg ha<sup>-1</sup> with tissue N & P below "sufficiency"
- We're adding value to the NC Yield Contest by analyzing tissue and soil of Contest entries to determine **whether nutrient deficiencies become apparent at high yield, and if nutrients need to be within established sufficiency ranges.**

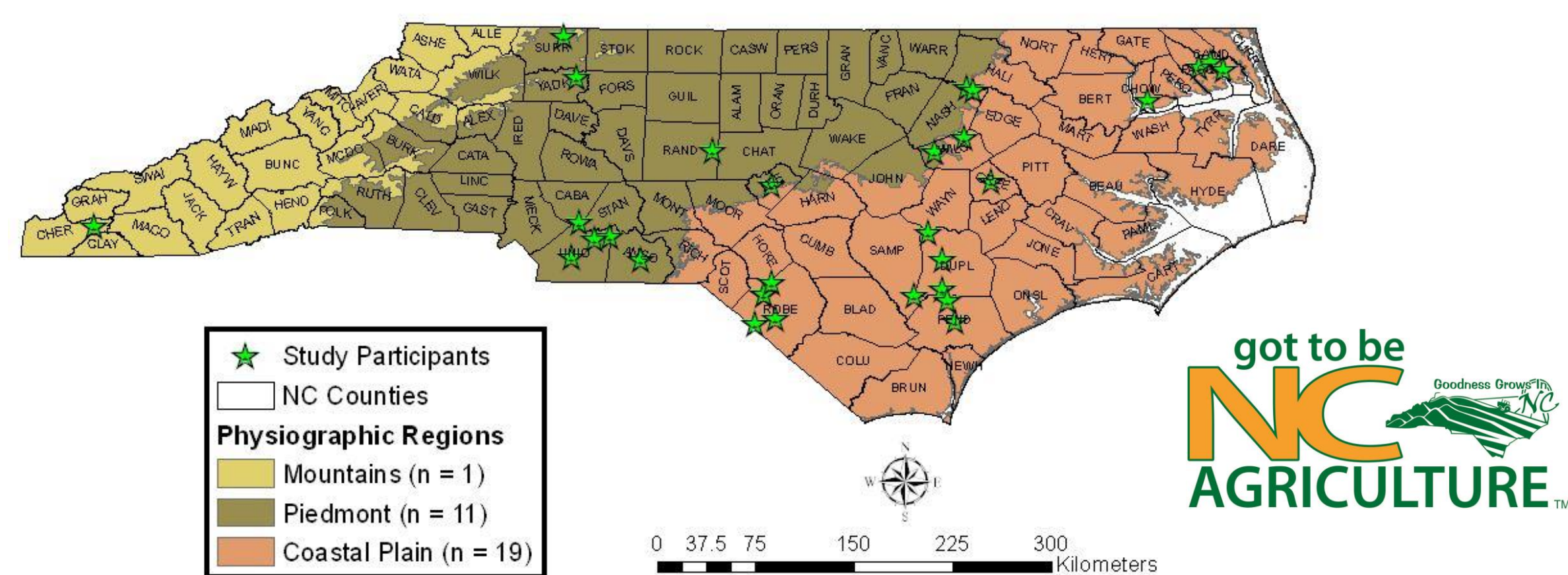
### Questions Being Addressed

- Are tissue macro- and/or micronutrient deficiencies apparent at high yield and do they become yield limiting?
- Do tissue nutrient levels need to be within established sufficiency ranges to produce high yields and are Contest growers achieving these levels?
- With high yield, are tissue nutrient levels correlated with yield components and yield?
- What are the Realistic Yield Expectation N-factors (apparent N-use efficiency: kg fertilizer N Mg<sup>-1</sup> corn) at high yield? A recent meta analysis showed that NC N factors have decreased.
- Are tissue nutrient levels at high yield related to: NCDA&CS soil test and/or management factors such as irrigation, tillage, hybrid, row width, population, and fertilization?
- Is there temporal variability in NCDA&CS soil test and is it associated with that of tissue nutrients?

### Materials & Methods

- Created a [Study website](#) (center, top) and a [Qualtrix enrollment survey](#)
- Mailed 510 postcard invitations (below) to recent contest entrants,
- Emailed invitations to the [13 NC Dept. of Agriculture and Consumer Services \(NCDA&CS\) Regional Agronomists](#), the [110 NC Extension Service](#) field agents, plus 134 professionals from the tri-societies "[Find a Professional | Search](#)".
- Engaged the NCDA&CS Agronomic Division Soil and Plant Analysis Laboratories, which agreed to charge us grower fees (soil=\$0, tissue=\$5) rather than research fees (\$5, \$12) (Thanks!)
- From [NCDA&CS blank sample information forms](#), created [pre-filled/prepaid](#) .pdf versions to facilitate sample submission and payment.
- From areas intended for contest entry, sampled [tissue](#) and [soil](#) at [<V6, V6+, VT-R1, and R6](#).

Fig. 1. Locations of study participants



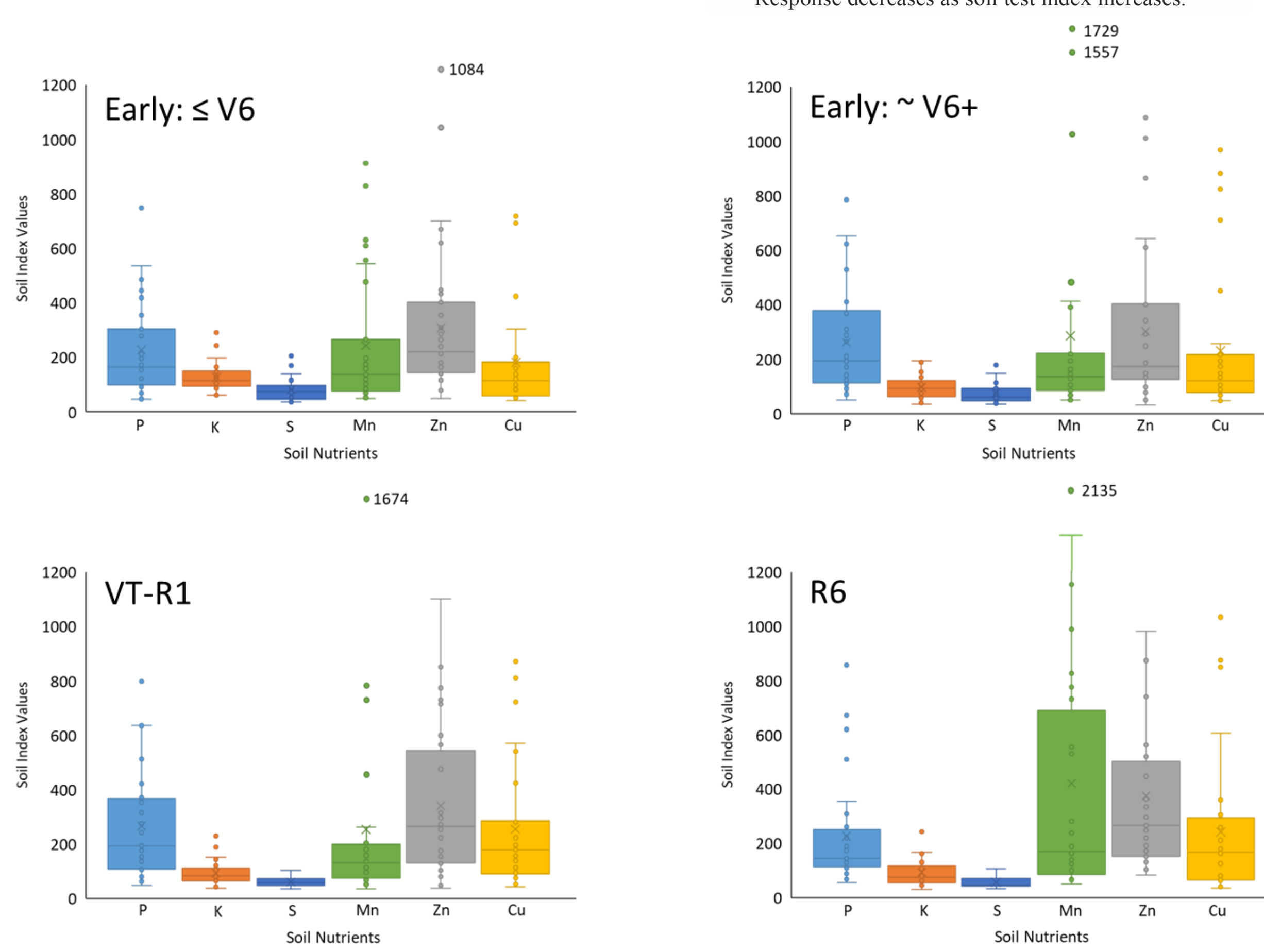
### Results: Enrollment & Sample Submission

- Applications started: 85, number completed: 50
- 45 growers, predominantly from the Coastal Plain (Fig. 1), 7 regional agronomists, 10 Cooperative Extension agents, 5 consultants, and 2 "other" enrolled.
- Most agronomists/agents/consultants agreed to recruit and work with >1 grower.
- We offered to sample/assist, but all participants agreed to follow website sampling instructions, complete information forms, and submit samples to NCDA&CS.
- As of October 17, there are 32 known participating growers submitting samples from 48 contest fields, mostly in the Coastal Plain. There may be more: growers could stockpile samples and send them in after harvest.
- A total of 148 tissue and 118 soil samples have been submitted to date.
- Of these: There are only 6 complete sets (4 each plant & soil), 8 sets of 3 samples, 6 of 2 samples, and a variety of other combinations. Predominantly absent are early samples

### Study Website

### Soil Analytical Results

Fig. 2: Nutrient analyses of soils sampled at four corn growth stages. Expressed in the NC Dept. of Agriculture and Consumer Services soil nutrient index system



NC Dept. of Agriculture and Consumer Services Soil Nutrient Index System

Index	Nutrient Status	P	K	Mn	Zn	Cu	S
0-10	Very Low	VH	VH	VH	VH	VH	VH
11-25	Low	H	H	H	H	H	H
26-50	Medium	M**	M**	N	N	N	M
51-100	High	N	L/N	N	N	N	L/N
100+	Very High	N	N	N	N	N	N

\* Crop response to fertilizer is expected to be very high (VH), high (H), medium (M), low (L) or none (N).  
\*\* Response decreases as soil test index increases.

### Conclusions

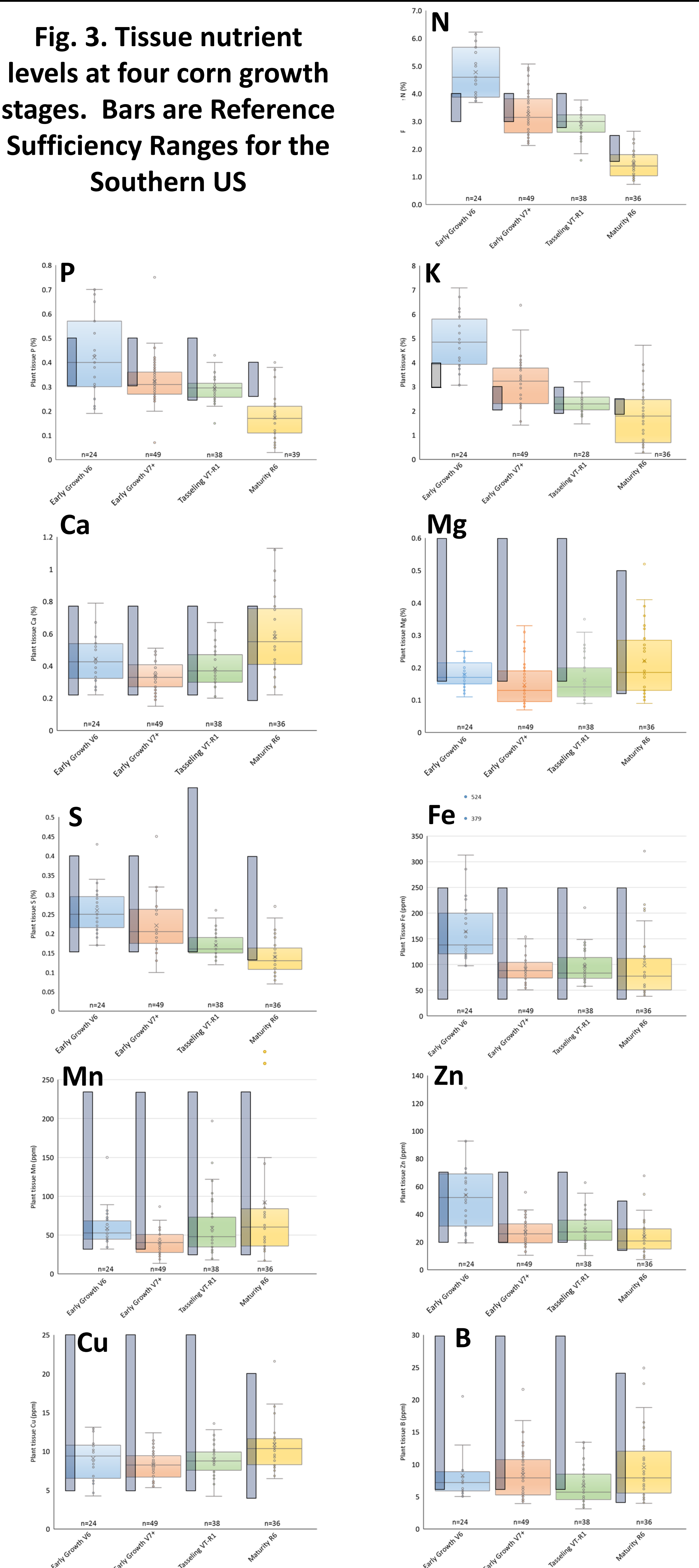
- Number of participating growers was disappointing. We will increase recruiting at commodity group and Extension Agent meetings and target mailings to 2016 Contest entrants.
- Soil Mn spiked at R6 (Fig. 2). Other soil nutrients were relatively constant season-long, most well above responsive levels. (NB: NC has no reliable N index methodology.)
- Tissue N, P, K: excessive or sufficient early, deficient late, albeit when ranges tend to be less reliable (Fig. 3). S and Fe also decreased early to late. Mg appeared deficient mid-season.

#### Future work :

- Compile and analyze yield and management data from Contest entry forms. Interpret tissue data using the Diagnosis and Recommendation Integrated System (DRIS), Compositional Nutrient Diagnosis, and the unbiased nutrient balance diagnosis of Modesto et al. (2014).
- Resample soils this Fall and Winter, repeat entire study 2018.

### Tissue Analytical Results

Fig. 3. Tissue nutrient levels at four corn growth stages. Bars are Reference Sufficiency Ranges for the Southern US



### Acknowledgements

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- Thanks to all of the participating growers and special thanks to the Extension Agents and Regional Agronomists who performed the majority of the sampling.
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