Irrigation Discussion Group Focus Paddock Report

High Yielding Maize Nutrition Trial

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Focus Paddock Summary

The aim of this demonstration was to ensure no nutrients were limited to see what yield may be possible, and to also evaluate the effect of a late application of nitrogen.

As no increase in yield was obtained the additional applied nutrients did not result in an increase in yield, i.e. no financial benefit was obtained.

Background & Paddock Aims

As maize yields have increased over the past number of years the total plant uptake and nutrient removal has also changed. Bender et al., 2013 conducted research in the US in an attempt to determine what the total nutrients were required to produce a maize, including when these nutrients are required, and the partitioning. The Nutrient harvest index was then calculated as the content of nutrients in the grain relative to the total above ground nutrient uptake.

Based on the US study Bender et al., 2013 a maize crop of 23.0 Tonnes/Ha above ground biomass, with a 12.0 Tonne/Ha of grain contained 286 kg of Nitrogen,49.8 kg of Phosphorus, 167.7 kg of Potassium, 59 kg of Magnesium, 26 kg of sulphur, 1.4 kg of Iron, 0.5 kg of both Manganese and Zinc, 0.1 kg of Copper, and 0.08 kg of Boron.

The timing of nutrient uptake has also been widely studied. Some research (Sayre, 1948 and Hanway 1962) have found that most rapid uptake of nitrogen occurred immediately prior to tasselling, with some uptake also occurring during grain fill. More recent studies (Bender et al., 2013) have found that the timing of uptake was specific to nutrients, and was associated with both the vegetative or reproductive growth stages.

Some nutrients are also highly mobile within the plant and can translocate to the grain following silking. These nutrients include nitrogen, phosphorus and zinc, while the micronutrients like boron, manganese, copper, and iron are not very mobile (Sayre, 1948; Hanway, 1962, Karlen et al., 1988). The mobility of the nutrients influences the proportion of the nutrient which will be translocated to grain. Bender et al., 2013 found that the there was a variation in nutrient uptake between maize hybrids. The total nutrient uptake that was partitioned to the grain (Harvest Index) is shown in Table 1.

Nutrient	Harvest Index (%)
N	58
P	79
K	33
Mg	29
S	57
Zn	62
Mn	13
B	23
Fe	18
Cu	29

Table 1: Percentage of total nutrient uptake present in grain (Bender et al., 2013)

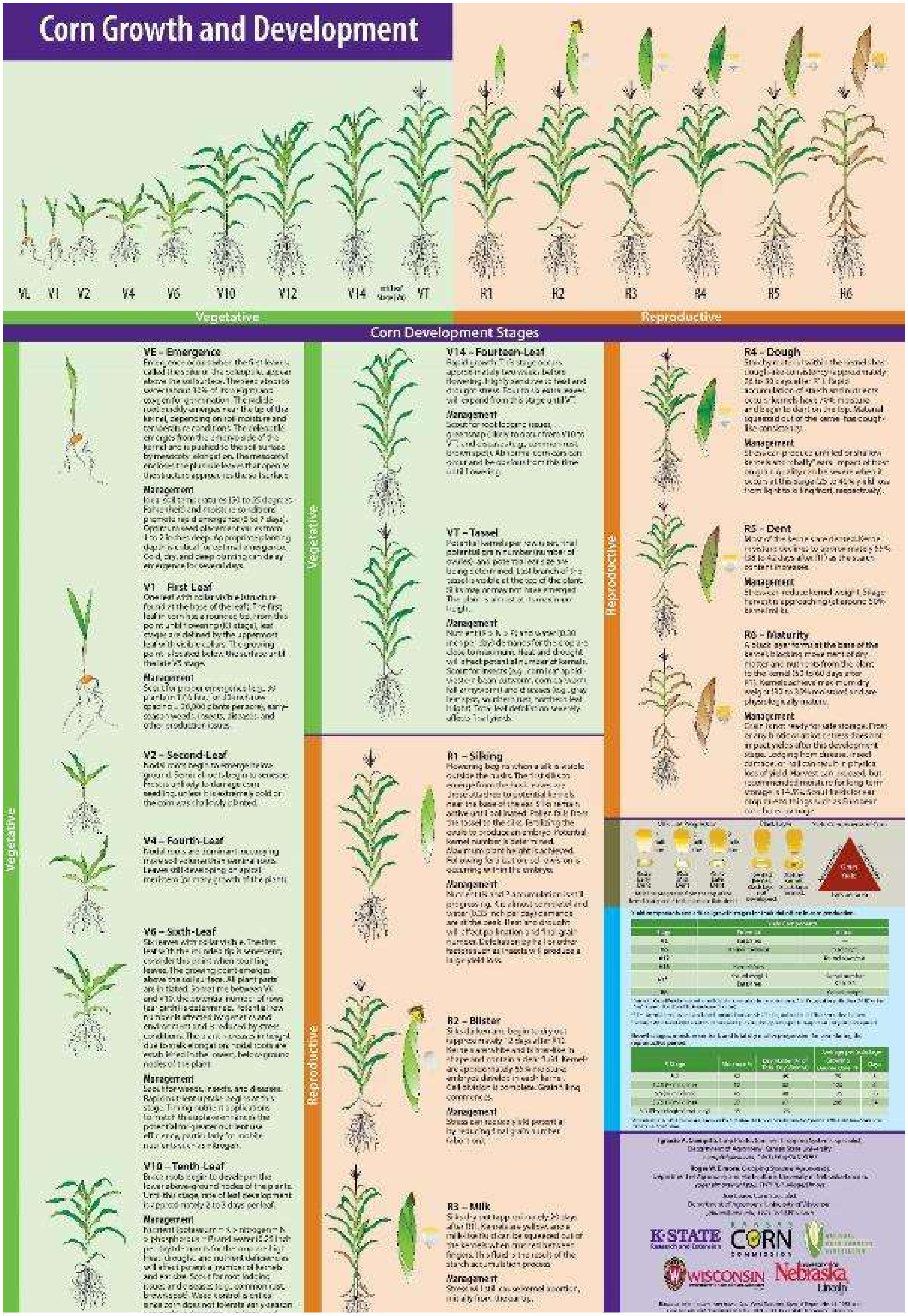

Figure 2: Maize Growth Stages

The timing of uptake also varies depending upon the specific nutrient. Bender et al., 2013 found that as much as two thirds of the N, K, Mg, Mn, B and Fe were taken up prior to flowering, whereas only half of the P, S, Zn and Cu. In addition it was found that both Zn and Cu were also required during grain fill. Previous studies (Hanway, 1962) had found that the majority of the o and K uptake occurred prior to flowering.

The maximum rate of plant growth (dry matter production) occurs just prior to tasselling, and then again as the silks dry off. The maximum nutrient uptake also corresponds to the period just prior to tasselling (Bender et al., 2013). Nutrient uptake will also continue right through until maturity for N, P, K, Mg, S, Zn, Fe and Cu.

Nutrient application for maize production in Australia does greatly vary across the production region. One of the highest yielding commercial growers applies the following nutrients:

1. Preplant: N 115.28, P 19.14, K 54.45, S 8.8, Zn 0.88
2. Planting: N 7.998, P 11.223, Mo 0.05, Zn 0.8, Na 0.024
3. In Crop: N 207

Focus Paddock Details

Location	Boort
Crop type	Maize
Irrigation system	Drip Irrigation

Methodology

Maize was sown 7 November 2019, with the variety in the trial area being P1756. Harvest occurred between the 17-25 April 2020. Yield was recorded via the yield monitor in the header, and mapped using Climate Fieldview™.

Block monitoring was conducted throughout the season by Scott Palmer from SLTEC. Tissue tests collected at three key growth stages were sent to SWEP for analysis. Tissue tests were used to inform the grower if nutrients in the crop were adequate to achieve the desired yield, and if not, then what was required to correct a deficiency or toxicity.

The three key times for conducting a tissue test were:

1. When the crop is less than 30cm in height (Figure 1)
2. When the crop is over 30cm in height but has not begun to tassel (Figure 2)
3. When the crop is at 50% silking (Figure 3)

Figure 1: First sampling stage

Figure 2: Second sampling stage

Figure 3: Third sampling stage

1. **Unlimited SLTEC Trial**

The application and timing of the nutrients applied during the season was determined based on the tissue analysis conducted at the three key stages. The total program consisted of the following:

- 200 kg/ha urea pre drilled
- 120 kg/ha granulock Z predrilled
- 280 kg/ha DAP predrilled
- 80 L/ha Corn Popup™ (8.8:11.1:0) in furrow at planting
- 550 kg/ha urea fertigated throughout the season (including post January) Approx Weeks 5,7,9,11. (approx. 11/12/19, 25/12/19, 8/1/20, 22/1/20)

Foliar:

- 29/11/19 applied 10 L/ha High PZ™ (0:18:2:14.1)
- 11/12/19 applied 20 L/ha High PZ™
- 16/12/19 applied 4 L/ha of Relax™ (to help the crop deal with the high expected temps)
- 15/1/20 applied 100 L/ha of Natures K ™ (0.6:1.8:10)

2. **Farmer standard/control**
   - 200 kg/ha urea pre drilled
   - 120 kg/ha granulock Z predrilled
   - 280 kg/ha DAP predrilled
   - 40 L/ha 10:14+Zn in furrow at planting
   - 550 kg/ha urea fertigated throughout the season. Approx Weeks 5,7,9,11 (approx. 11/12/19, 25/12/19, 8/1/20, 22/1,20)

Agronomic results

Nutrient			Results 22/11/19	Results 3/1/20	Results 15/1/20	Results 6/2/20	Desirable Level Range
Nitrogen	N	%	4.7	3.34	3.33	2.64	3.5-5.0
Phophorus	P	%	0.431	0.36	0.394	0.305	0.35-0.6
Potassium	K	%	4.94	2.57	2.45	1.9	2.1-3.0
Sulphur	S	%	0.298	0.2	0.22	0.209	0.15-0.50
Calcium	Ca	%	0.51	0.31	0.311	0.523	0.3-1.0
Magnesium	Mg	%	0.275	0.24	0.258	0.294	0.25-0.50
Sodium	Na	%	0.0225	<0.05	0.0074	0.00814	<0.3
Iron	Fe	ppm	181	153	198	376	50-250
Manganese	Mn	ppm	79	51	54.6	57.7	40-100
Zinc	Zn	ppm	40.2	28	40.3	29.6	20-60
Copper	Cu	ppm	9.09	9.9	10.2	10.7	7.0-20.0
Cobalt	Co	ppm	0.121		0.125	0.243	NA
Boron	B	ppm	21.7	30	30	19.4	8.0-38.0
Molybdenum	Mo	ppm	0.218	0.45	0.497	1.05	0.2-0.5
Chloride	Cl	%	0.823	0.55	0.269	0.308	<1.0

NB. Yellow cells indicate an excess, Red indicate a deficiency (based on guidelines from Reuter & Robinson, 1997)

Figure 4: Tissue testing results, Unlimited Trial site

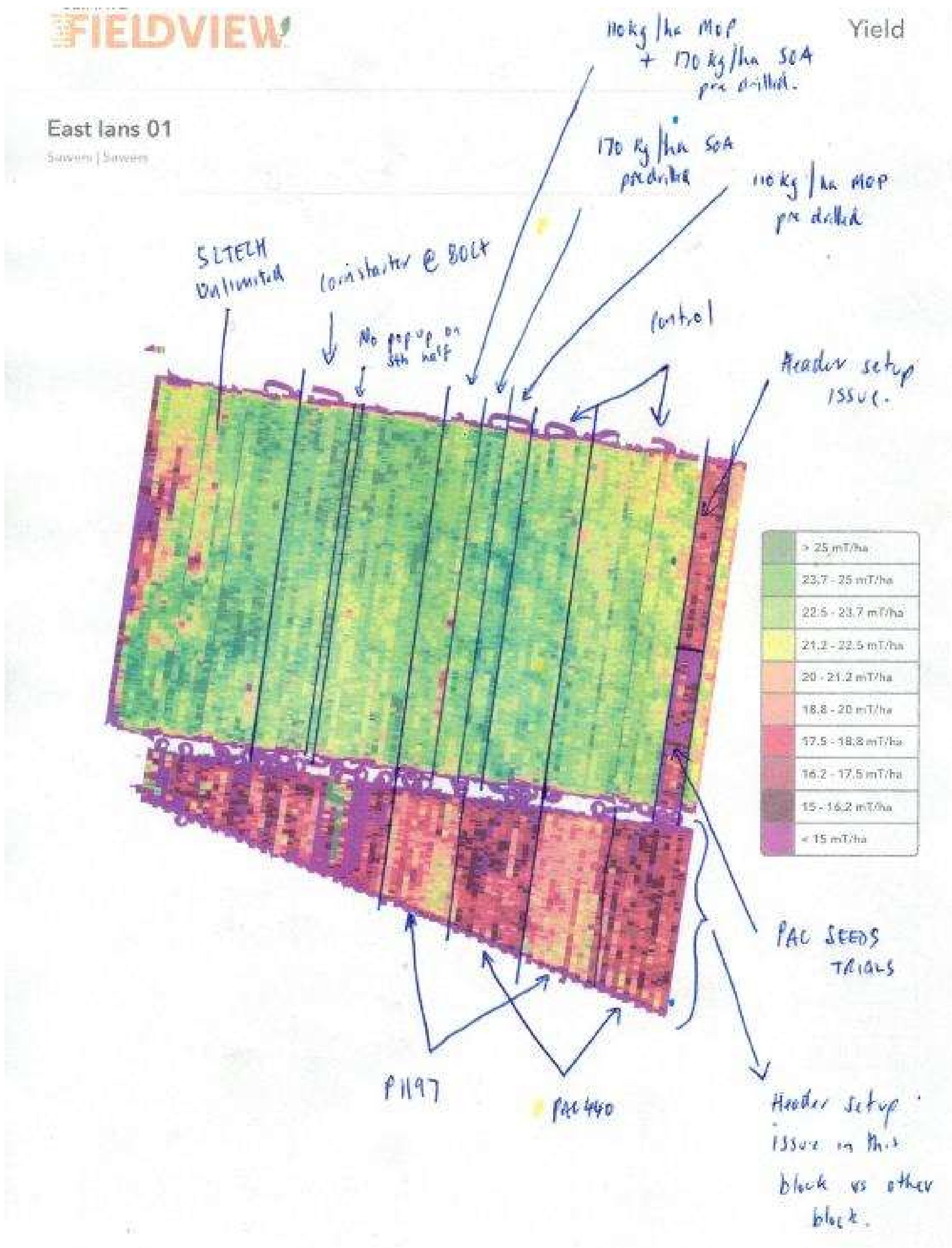

Figure 3: Yield Map Part B

Economic results

As shown in Figure 5 there was considerable yield variation within the various treatments which has made it difficult to determine what differences may exist between treatments. This is often the case with farmer's trials as single strips within the paddock are compared against each other. Based on the yield map (figure 5) a difference in yield between the “Grower Standard” and “Unlimited Nutrients” was not evident.

Hence, the additional applied nutrients did not result in an increase in yield, i.e. no financial benefit was obtained.

Key learnings & recommendations

Additional N was applied to the entire area during the season, until the 3rd week of January. The nitrogen level still continued to fall below the desirable range from Reuter & Robinson (1997) even with these applications, with a further decrease observed past the end of January. This indicates that additional applications of late season N were required.

Additional P and Zn was applied to the SLTEC unlimited trial in both late November and December. Given this the P level still continued to appear marginal into January.

As the K levels in the plant appeared to be dropping in mid January additional K was applied to the crop. Following this application the drop in K continued in the plant tissue, although it could be assumed that without this late K application the drop in K may have been to a greater extent.

As no increase in yield was obtained the additional applied nutrients did not result in an increase in yield, i.e. no financial benefit was obtained.