Agronomic Technical Bulletin

SULPHUR IN CORN PRODUCTION

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A corn field is a huge factory capturing sunlight to manufacture glucose that is utilized with nutrients taken up by the root system to produce the end product called corn kernels. Corn is the primary grain crop produced in North America. There have been significant amount of research, management schemes, economic assessments, and production education focused on this crop. Throughout the 2000's many researchers and corn producers targeted yield goals of 300 bushels per acre (bu/ac). During the past 2-3 years it has become more common to learn of farmers harvesting more than 350 bu/ac. Current target goals are reaching for 500 bu/ac. Many factors influence potential crop yield including management intensity, soil fertility, hybrid genetics, insects, diseases, weeds, environment and soil moisture. Generally, the greatest yield limiting factors are soil moisture and soil fertility. Most corn farmers will agree that the greatest yield potential of a crop is when seed is in the bag. Once the seed is planted it is influenced by the previous mentioned factors that reduce yield potential. The ability to understand the growth process of the crop enhances the producer's ability to preserve yield potential by minimizing stress factors, especially during critical growth periods.

CORN GROWTH STAGES

To universally communicate the corn growth stages and better understand the growth periods, researchers at Iowa State University introduced a system to identify corn growth stages that has become the standard in the industry. This system classifies growth into vegetative (V) and reproductive (R) stages (Table 1.0). Each stage designated numerically as V1, V2, V3 and so on. Each number represents the uppermost leaf with a visible collar, with the leaf collar being a visible light-colored narrow band at the base of the leaf Figure (1.0). The last vegetative stage is named VT, to denote tasseling. The reproductive stages (R) relate to the development of the kernels, with the R1 stage being characterized by the silks being visible outside the husks Figure 1.1 (Ritchie et al. 1997).

Figure 1.0 Corn leaf collar.
Photo: Univ. of Wisconsin

Figure 1.1 Corn at silking, R1
Photo: Mississippi State Univ.

Table 1.0
Vegetative and Reproductive Stages of a Corn Plant

Vegetative Stages	Reproductive Stages
VE emergence	R1 silking
V1 first leaf	R2 blister
V2 second leaf	R3 milk
V3 third leaf	R4 dough
V(n) nth leaf	R5 dent
VT tasseling	R6 physiological maturity

(Ritchie et al., 1997)

Table 2.0
Critical Corn Growth Stages

Growth Stage	Days after Emergence	Growth Event	Importance
V3	9-12	Seminal root system and ear shoots initiated	Seedling vigor seen, ears established
V4 to V5	14-21	Ear shoot initiation complete	Number of kernel rows determined
V6	21-25	Nodal root system established Growing point above soil surface	Plants ability to take up nutrients and water
V12 to V14	42-49	Number of ovules determined	Number of kernels per row initiated
R1 (silking)	63-68	Pollen shed begins, brace roots establish, near maximum root mass	Kernel fertilization, support ear weight, kernel fill

(Ransom, J. 2013)

CORN RESPONSE TO SULPHUR

To maximize the production potential stress and yield limiting factors must be eliminated or minimized throughout all growth stages. Each growth stage has its physiological and biological importance in the development of dry matter accumulation and ultimately corn yield (Table 2.0). Sulphur nutrition can remove one yield limiting factor and minimize impact of other nutrients that may be potentially limiting yield.

When a soil test analysis reveals the sulphur level is below 10 parts per million (ppm), it could be an indication of a deficiency. A preplant application of 25 -30 pounds per acre (lbs./ac) of actual sulphur or 28 – 34 lbs./ac of TIGER® 90CR is recommended. Figures 2.0 and 3.0 illustrate the impact sulphur has on enhancing corn yields.

Corn Response to T90CR

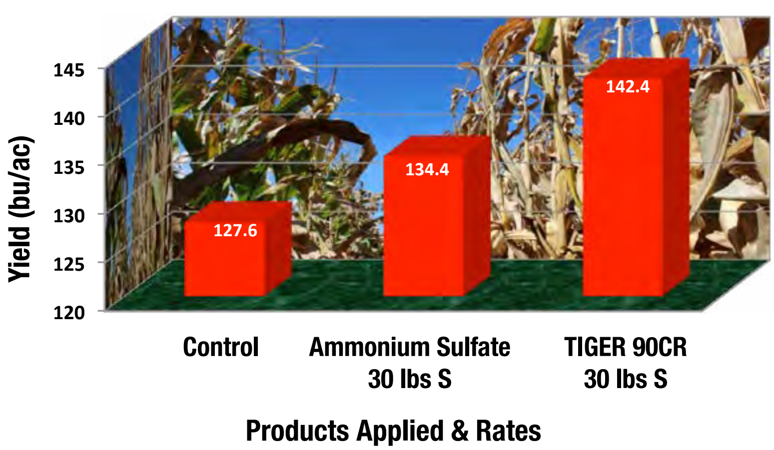

Figure 2.0
Comparison of corn yield with TIGER 90CR and Ammonium Sulphate (AMS). Results average of 4 years with significant difference between treatments.

Corn Response to T90CR

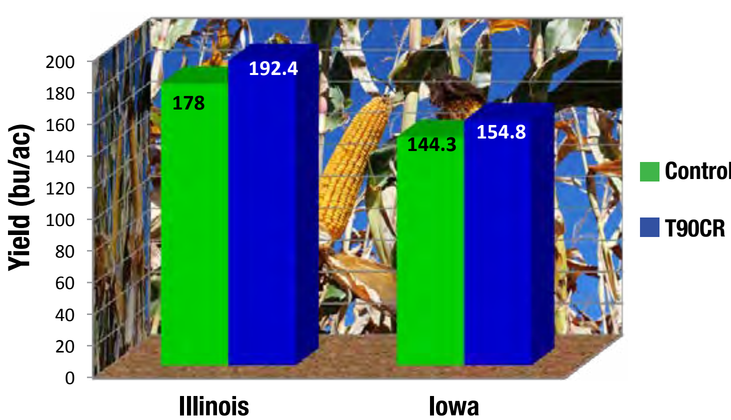

Figure 3.0
Corn responses to TIGER 90CR at two locations.

Sulphur is not mobile in the corn plant and is dependent on continuous supply of available sulphur in the soil throughout the growing season. Approximately one-half of the corn plant's sulphur requirement and uptake is between R1 – R6 growth stages. This sulphur uptake response is compared to nitrogen, phosphorus, and potassium in Figure 4.0. Therefore, TIGER 90CR is a great fit with its control release characteristics as sulphur oxidation releases plant available sulphur gradually throughout the growing season. When sulphate products are lost to leaching and plant uptake during the early growth periods, TIGER 90CR release of sulphate may increase in mid-late growth periods when sulphur oxidation process is somewhat faster due to higher micro-organisms population and higher soil temperatures.

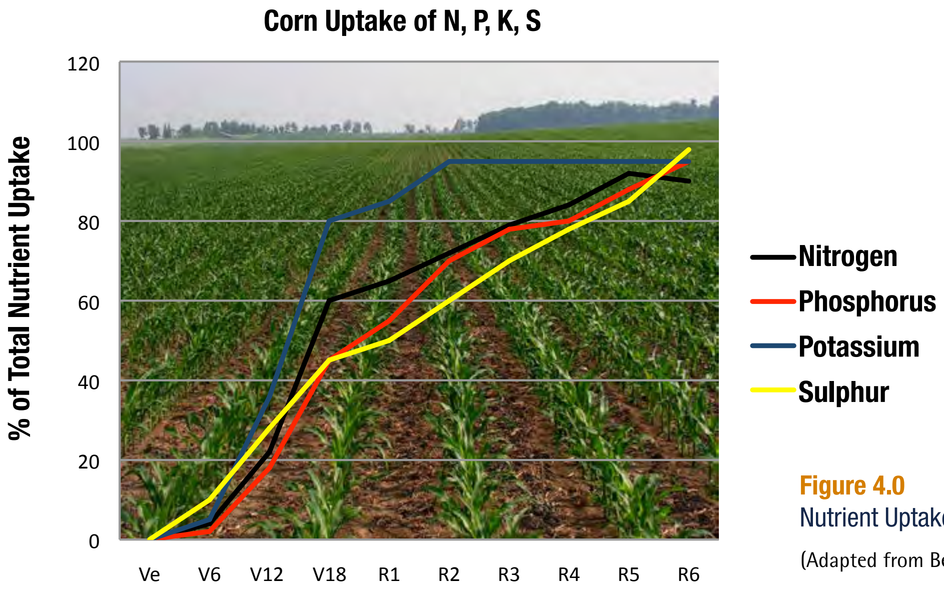

Figure 4.0
Nutrient Uptake By Corn at Various Growth Stages.
(Adapted from Bender et al., 2013. Ritchie et al., 1997.)

Corn needs micronutrients in relative small amounts; however, higher corn yields, variations in soil types, and regional weather patterns influence the soils ability to supply sufficient quantities of micronutrients for optimum corn growth. Zinc is the micronutrient most likely to be found deficient for corn. The deficiency typically occurs at the V2 through V8 growth stages. Analysis of plant tissue during the growing season and comparison of these results over time against published standards is the best way to assess micronutrient status (Espinoza & Ross). Table 3.0 presents acceptable values of plant nutrients in corn plant tissue. Values below those in the table would indicate a nutrient deficiency. Preplant application of 10 pounds actual zinc or 56 pounds per acre of TIGER Micronutrients® Zinc 18% is recommended. This rate of TIGER Micronutrients Zinc 18% will provide 36 pounds of sulphur.

Table 3.0
Plant Tissue Sufficiency Ranges for Corn By Growth Stage
(Adapted from Southern Series Cooperative Bulletin 394.)

	N	P	K	Ca	Mg	S	Mn	Zn	Cu	B
Growth Stage	%						ppm			
Seedling	4.0-5.0	0.4-0.6	3.0-4.0	0.3-0.8	0.2-0.6	0.18-0.5	25-160	20-60	6-20	5-25
Early Growth	3.0-4.0	0.3-0.5	2.0-3.0	0.25-0.8	0.15-0.6	0.15-0.4	20-150	20-70	5-25	5-25
Silking	2.8-4.0	0.25-0.5	1.8-3.0	0.25-0.8	0.15-0.6	0.15-0.6	15-150	20-70	5-25	5-25

SULPHUR INFLUENCE ON PLANT NUTRIENT EFFICIENCIES

Various research projects have demonstrated some synergies when sulphur was included in the plant nutrient management program. Sulphur enhances the plant uptake and utilization of other nutrients (Figure 5.0).

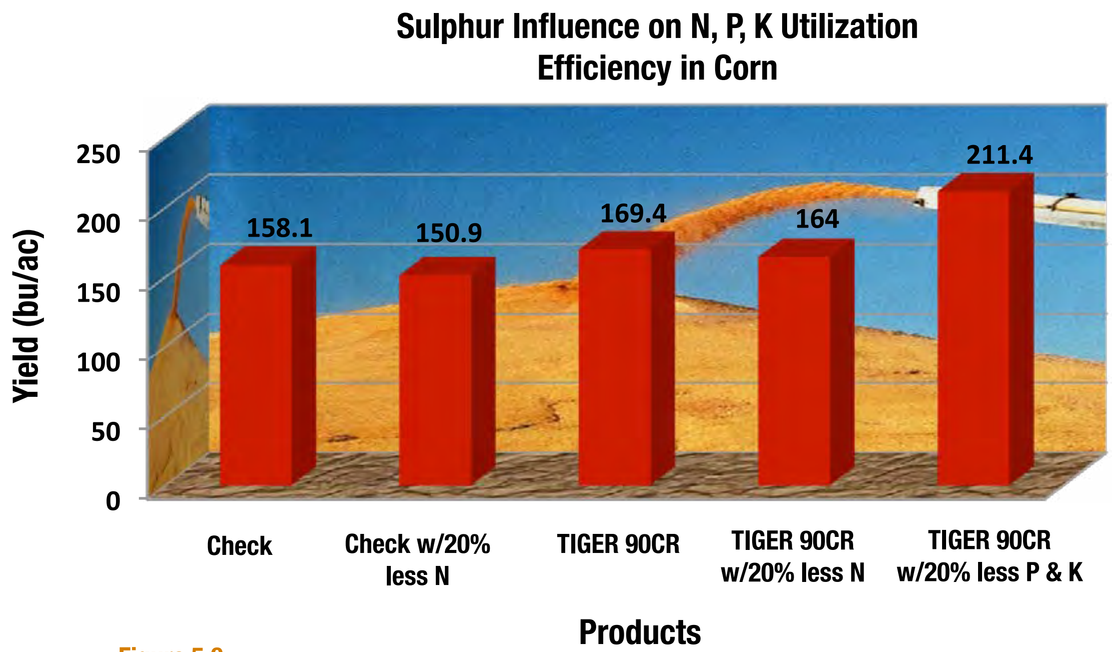

Figure 5.0
Corn yield as affected by reduction in nitrogen, phosphorus, and potassium. Sulphur rate was 30 lbs/ac in all comparisons.

The data in Figure 5.0 is average of three years at one location and reflects no significant yield reduction when TIGER 90CR was included at 30 lbs/ac with 20% reduction in nitrogen rate. A more interesting response was the increased yield with reduced rate of phosphorus and potassium. It is possible that the sulphuric acid released from the sulphur oxidation altered the soil pH in the rhizosphere such that corn roots were more efficient in uptake of each nutrient. Granted, this is not sufficient data to support a recommendation to reduce N, P, K rates 20% on corn when 30 lbs/ac of sulphur is included, but is a positive indication that balanced plant nutrition enhances nutrient uptake and crop production.

Corn is an interesting crop that responds to intensive management. Yield goals of 500 bu/ac will become a reality in near future as research and technology reveal new and improved efficiencies in managing corn production. Soil fertility will be an integral component in the future success of the great corn factory. Within the dynamics of soil fertility, sulphur will be a major contributor to the overall influence of crop response.

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