TIGER® TECH NEWSLETTER

INNOVATE, EXCEL, PERFORM | MAY, 2016

Differences in Plant Nutrient Uptake and Plant Nutrient Removal

Wesley Haun, Agronomist

Many factors influence plant growth including sufficient nutrition. The volume of plant nutrients applied as fertilizer varies with concentration of available nutrients in soil, crop requirements, yield potential, growing season, and management intensity. These interacting factors compound the decision making process to assess the correct amount of plant nutrients to add to the soil system to insure the crop has sufficient supply of all nutrients.

Nutrient Removal

One method of evaluating fertilizer application rates is based on crop nutrient removal. Nutrient removal is the quantity of nutrients removed from the field in the harvested portion of crop. "Crop nutrient removal is commonly estimated from measured yields and published nutrient concentrations" (Murrell, 2008). For example, the sulphur (S) removal rate of alfalfa has been estimated by multiplying 5.4 lbs S/ton by the tons of harvested hay. A flaw in this method can occur as the forage moisture level is not referenced. Same would apply to a grain value as the volumetric measurement is utilized instead of a mass measurement. A further compounding factor in using crop removal value is the ability of soil to retain and supply plant available nutrients is not considered. Granted, it may provide variations in nutrient requirements of different crops and potential rate of decline in nutrient reserves within the soil system (Osmand & Kang, 2008).

A balanced nutrient management program strives to achieve approximate equal amounts of plant nutrient additions as amount of nutrients removed from the soil system in the harvested crop. A balanced system's goal is to maintain soil test levels of the immobile nutrients at relatively constant values and is referenced as maintenance applications (Murrell, 2008).

When the nutrient levels in the soil system are deficient nutrient additions are incorporated into management program to supply sufficient nutrients for current crop and build up soils over 3-4 years to support economic crop yields. To maintain soil fertility levels an inventory of available nutrients must be evaluated with soil sample analyses and replace nutrients that are removed with harvested crop and other loss mechanisms.

THE TIGER® TECH QUARTERLY NEWSLETTER

CONTACT INFORMATION

TIGER- SUL
CorporateHeadquarters
4 Armstrong Road, Suite220
Shelton,CT06484
203-635-0190(phone)
203-227-8351(fax)

TIGER-SUL Products (Canada) Co.
P.O. Box 126
275137 Range Road 263
Irricana, AB TOM 1BO, Canada
877-299-3399
403-935-4197 (direct)

TIGER-SUL Products LLC.
25 Byrne Drive
Atmore, AL 36502, USA
800-239-3647
251-202-3850 (direct)
251-368-4964 (fax)
Mailing Address:
P.O. Box 5; Atmore, AL 36504, USA

info@tigersul.com
www.tigersul.com
www.gotboron.com

Generally fertilizer recommendations are provided based on crop removal when plant nutrient levels in soil are in the optimum range. If the soil system is deficient, then crop removal and a soil build-up addition is included.

This recommendation system is primarily for phosphorus (P) and potassium (K). Both nutrients react in soil environment and become part of the cation exchange complex. Those nutrients combined within the cation exchange complex are held in place and are not subject to leaching and loss mechanisms. Soil sample analyses can predict plant availability of phosphorus and potassium. Nitrogen (N) is a primary nutrient but it is not analyzed for availability in most soil analyses. Yes, in specific situations for certain crops nitrogen tests are conducted. Generally, nitrogen recommendations are based on crop need or crop uptake. These recommendations vary by regions/states as established by land grant university research. When some nitrogen fertilizer products are soil applied, they are acted upon by soil bacteria to convert them to ammonium (NH_4) and nitrate NO_3 which are the plant available forms. Other forms of nitrogen are immediately available for plant uptake when they dissolve in the soil water. The NH_4 can attach to soil particles in the cation exchange complex and be stable, but the NO_3 is negatively charged and does not become a part of the cation exchange and is subject to the various loss mechanisms within the soil environment.

Sulphate (SO_4) reacts in the soil very similar to NO_3 as it is negatively charged and does not become a component of the cation exchange complex. The elemental sulphur forms are acted upon by bacteria to convert to SO_4. The various SO_4 fertilizer forms are immediately plant available following soil application and dissolving in soil water. Soil sample analyses for S cannot consistently predict potential crop response. There are multiple sulphur extractants utilized by soil laboratories and no standard has been established nationwide. Although, a soil analysis can provide an indication of SO_4 available at the time the soil sample was collected. Therefore, it would appear that the appropriate approach to providing sulphur recommendations would be based on the crop uptake requirements. As shown in Table 1.0 some crops such as cotton, rice, and sugar beets have small amounts of sulphur removal at harvest and a high uptake requirement to optimize growth potential. If fertility recommendations are based on crop removal of sulphur there is possibility that insufficient sulphur would be provided in the fertilizer application.

The TIGER-SUL Products are elemental sulphur with bentonite to effectively and efficiently provide season long sulphur and/or micronutrients for your crop. Bentonite is included in TIGER-SUL products to absorb moisture following soil application to enhance fracturing of sulphur pastilles into very small particles. The smaller particles provide greater surface area for soil bacteria to feed on the sulphur and convert it to plant available sulphate at a faster rate than other elemental sulphur products. An additional benefit is increased availability and uptake efficiency of other essential nutrients. Research studies have shown that sulphur can reduce nitrate leaching by contributing to NO_3 uptake efficiency. TIGER-SUL products provide needed sulphur and micronutrients to optimize crop yield. Their slow release characteristics potentially minimize soil system loss of valuable nutrients and fit well into the 4R nutrient management strategy.

References:

1) Ankerman, D. and R. Large. Agronomy Handbook, Midwest Laboratories
2) Bender, R.R. et al., 2015. Modern Soybean Varieties' Nutrient Uptake Patterns. Agron. J. 107:563-573.
3) Bender, R.R., et al., 2013. Modern Corn Hybrids Nutrient Uptake Patterns. Better Crops 97 (1): 7-10.
4) Franzen, D. and C.A. Grant. 2008. "Sulfur Response Based on Crop, Source, and Landscape Position". In Sulfur: A Missing Link between Soils, Crops, and Nutrition. J. Jez (ed.) Agronomy Monograph No. 50.
5) Heckman, J.R. et al., 2003. Nutrient Removal by Corn Grain Harvest. Agron. J. 95:587-591.
6) Mallarino, A.P. et al., 2011. Nutrient Uptake by Corn and Soybean, Removal, and Recycling with Crop Residue. Integrated Crop Management Conference. Iowa State University.
7) Murrell, S.T. 2008. Measuring Nutrient Removal, Calculating Nutrient Budgets. Soil Science:Step-by-Step Field Analysis. Soil Science Society of America. Madison WI.
8) Osmond, D.L. and J. Kang. 2008. Nutrient Removal by Crops in North Carolina. North Carolina State University Extension.

When fertilizer, manure, and other additions exceed the crop needs over time can result in nutrient supply exceeding the soil's exchange capacity to retain nutrients. The excess nutrients can be subject to leaching, surface, and sub-surface drainage which may be an environmental concern.

Crop nutrient removal does not account for all of the nutrients plants need to grow, develop, and produce vegetation, fruit, seeds, and fiber that is collected at harvest. Crop residue contains nutrients that are released into the soil as it decomposes over time. The decomposition rate is variable and is difficult to estimate nutrient contribution value. Table 1.0 provides an estimated amount of sulphur removed from field at harvest in selected crops. Many variables influence crop response and demands on needed nutrients.

Some of those influential factors include crop variety, soil type, available moisture, growing conditions, and soil nutrient supply.

Sulfur Requirements of Various Crops

		Crop Removal	Crop Uptake ¶
Crop	**Targeted Yield**	**lbs. S/Ac**	**lbs. S/Ac**
Alfalfa	6 Tons/acre	31	42
Apple	500 Bushels/acre	20	24
Canola	60 Bushels/acre	20	30
Citrus (based on oranges)	25 Tons/acre	25	28
Corn	200 Bushels/acre	14	26
Cotton	1,500 lbs./acre	7	45
Peanut	5,000 lbs./acre	13	25
Rice	7,000 lbs./acre	5	17
Sorghum	100 Bushels/acre	9	15
Soybeans	60 Bushels/acre	10	17
Sugar Beets	30 Tons/acre	10	49
Sugarcane	80 Tons/acre	40	44
Wheat	80 Bushels/acre	7	20

¶ Required to achieve targeted yield

TIGER® TECH Newsletter

Sulphur requirements vary by crops and their extent of responsiveness to sulphur supply. Forage crops tend to remove greater volume of sulphur and other nutrients as the whole plant is removed during harvest. Whereas, in a grain crop only the seed is harvested and generally much less nutrient is removed from the field. The crop residue is recycled into the soil system and any accumulated nutrients within the plant are released during the decomposition process (Franzen & Grant, 2008).

Figure 1.0 Sulphur Uptake in Corn

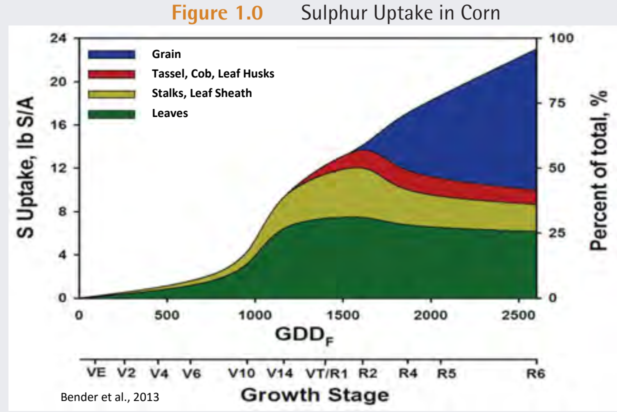
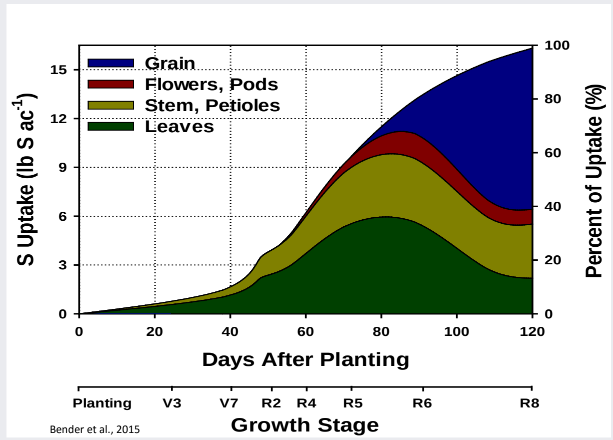


Figure 2.0 Sulphur Uptake in Soybeans



Nutrient Uptake

Plant nutrient uptake is the total amount of nutrients required by the plant to optimize its growth potential. Research assessments have been conducted of many crops to establish nutrient uptake values (Table 1.0). Those values are averages as differences occur by regions, growing conditions, management intensity, and etc. Research projects have been conducted to evaluate nutrient accumulation within various plant parts. The most recent data is from University of Illinois with corn and soybeans. Sulphur uptake was continuous throughout the growing season for corn and soybeans (Figures 1 & 2).

Sulphur uptake in corn began rapidly at V10 growth stage and continued until tasselling. During the reproductive growth stages sulphur followed a linear uptake pattern until maturity. There was 53% of sulphur removal in the harvested corn which indicates the importance for sulphur availability throughout the growing season. In soybeans substantial sulphur uptake began at V7 growth stage and increased significantly throughout reproductive growth stage. There was 59% sulphur removal in the harvested seed which implies the need for adequate supply of plant available sulphur during the reproductive growth stage. Corn is a monocotyledon and soybean is a dicotyledon which represents the two plant types, both require season long plant available sulphur.