



Macronutrients for 'Macro' Soybean Yields

Soybean Production in a New Era

While soybeans were introduced to the United States in the late 1800s as a forage source for cattle, it wasn't until 1935 that the number of acres for soybean grain exceeded forage-based acres. This milestone marked the beginning of a new era in soybean production, which has influenced the fertility needs of soybeans.

The USDA indicates that soybean yields have increased by nearly fivefold over the last 100 years. New research from the University of Illinois at Urbana-Champaign indicates that updated crop nutrition information for soybeans will be necessary to maximize soybeans' yield potential.

Research Highlights Need for Season-Long Nutrient Availability

To quantify the nutritional needs of soybeans, the Crop Physiology Laboratory at the University of Illinois measured nutrient uptake and partitioning on current varieties across multiple locations. Biomass and nutrient accumulation among different plant tissue fractions were measured throughout the growing season.

Results from the study examined biomass production and nutrient use for soybeans yielding 60 bu/ac (Table 1). Findings suggest that the higher yields associated with today's varieties not only produce more total biomass, but maintain this growth during seed filling at rates faster than previously thought (Fig. 1). Biomass production is the driving force behind nutrient accumulation, and as a result, more nutrients are now needed during seed filling than ever before.

This is especially true for phosphorus (P), with approximately 45 percent of total P accumulation taking place during seed filling (i.e., after the R4 growth stage). University of Illinois results indicate that maximum P accumulation occurs during this period at a near-linear rate of 0.7 lbs P₂O₅/ac/day for an extended 70-day period (Fig. 2). By contrast, peak accumulation of potassium (K) occurs during an estimated 50-day period, primarily during vegetative and early reproductive growth (Fig. 3). In short, maximum accumulation of crop nutrients occurs for a 50- to 70-day period in soybeans.

The densely concentrated nutrients in soybean seeds are obtained from either root uptake or nutrient remobilization. Research results suggest that leaves help to supply grain with P, compared to K, which primarily comes from stem tissues (Figs. 2 and 3). Leaf and stem tissues support grain needs during periods of elevated nutrient demand, and the development of these necessary resources is possible with balanced crop nutrition.

Nutrient Partitioning Leads to Rapid Nutrient Removal

The unique partitioning and use of nutrients in soybeans have significant ramifications from a fertility perspective. In fact, data from the University of Illinois indicate that more than 80 percent of P accumulated in both corn and soybeans is removed with grain harvest annually. Furthermore, the USDA estimates that only 20 percent of producers are supplying P during their current soybean crop. Soybean crops with inadequate nutrient replacement are thus required to accumulate P mineralized from organic matter, and scavenge the soil for residual P from applications typically made nearly 18 to 20 months earlier.

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Balanced Crop Nutrition the 'Right' Way

Right Rate: Replacing removed immobile macronutrients like P and K is the foundation behind sustainable soil management. (See removal rates in Table 1.) Use this information, in combination with soil test results, to ensure the greatest return on your fertilizer investment.

Right Time: Agronomic practices, nutrient sources and soil conditions, which most closely supply essential nutrients during known periods of nutrient accumulation, will maximize fertilizer recovery and soybean profitability (see Figs. 2 and 3). As a result, many universities continue to recommend annual P and K nutrient applications (instead of biennially) immediately before planting or side-dressed in season.

Right Place: Significant quantities of P and K are accumulated via diffusion and root interception processes. Consider incorporating nutrients as a best management practice to improve nutrient assimilation and simultaneously reduce the potential for environmental losses.

Right Source: Macronutrient sources alone cannot provide balanced crop nutrition. The use of fortified P and K fertilizers ensures more uniform application of secondary macronutrients and micronutrients for improved crop growth and yield. To learn how innovative P and K fertilizers improve distribution, season-long availability and uptake of plant-essential nutrients, please visit www.cropnutrition.com.

Consider the science behind nutrient accumulation in a new era of soybean production by providing your crop with macronutrients for 'macro' soybean yields. For more information, please see "Modern Soybean Varieties' Nutrient Uptake Patterns."¹

Table 1.

Macronutrient uptake and removal for a soybean crop yielding 60 bu/ac. Data were adapted from, Bender, et al. (2015)¹ and are reported on a dry-weight basis.

Parameter/ Nutrient	Maximum Uptake	Removal with Grain	Harvest Index	Nutrient Removal Coefficient*
	lbs/ac		%	lbs/bu
Dry Weight (Fig. 1)	8,497	3,105	37	—
P ₂ O ₅ (Fig. 2)	43	35	81	0.58
K ₂ O (Fig. 3)	170	70	41	1.17

*Multiple grain yield by nutrient removal coefficient for estimate of nutrient removal.

Uptake and partitioning for soybeans yielding 60 bu/ac.

Fig. 1. Dry Matter

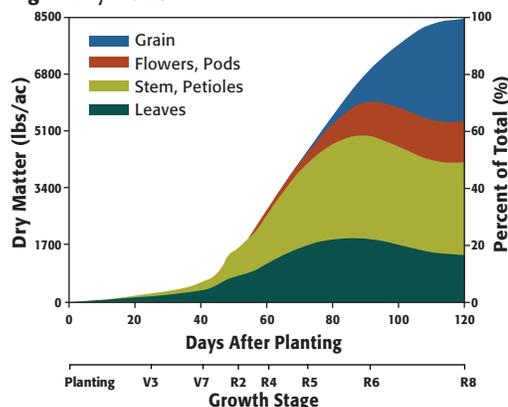


Fig. 2. Phosphorus (P)

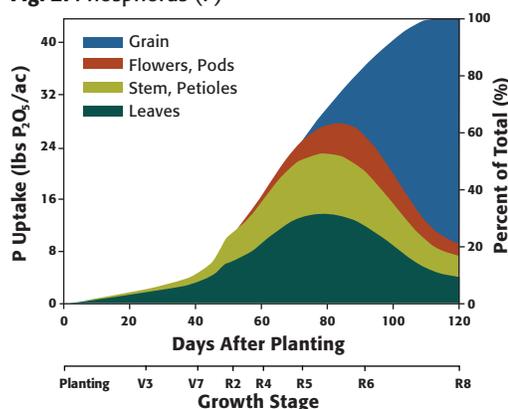
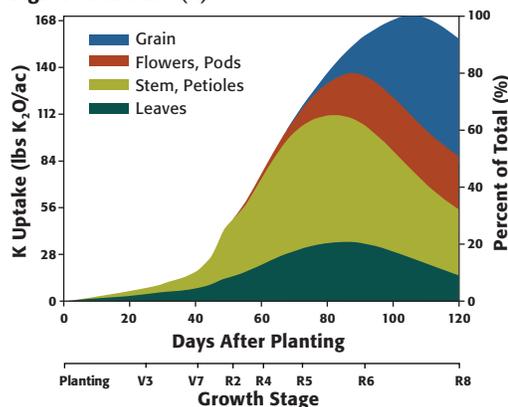


Fig. 3. Potassium (K)



> FACT

The USDA estimates that only 20 percent of producers are supplying P during their current soybean crop.



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¹Bender, R.R., J.W. Haegerle and F.E. Below. Modern soybean varieties' nutrient uptake patterns. *Better Crops with Plant Food* 2015;99(2):7-10.