Resource Partitioning in Cotton: Three Decades Later

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Overview

- The current fertilizer recommendations in cotton are based on testing of elite cultivars prior to 1990.
- Modern cotton cultivars are more compact and efficient, due to optimization of genetics and changed management practices.
- Improvements in yield potentials can be associated with the changes in nutrient allocation.
- It is time to re-evaluate nutrient accumulation and requirements in modern high productivity cultivars.
- Re-evaluation of resource requirements can help optimize fertilizer application and cost efficiency and update nutrient uptake indices for modern cotton cultivars.

The objective of this study is to compare the resource allocation of modern cultivars with older ones based on yields, partitioning of nitrogen (N), phosphorus (P), and potassium (K) to different organs, as well as nutrient uptake per unit of lint produced in irrigated, fertilized cotton.

Materials and Methods

- Location: Texas Tech University Research Farm, New Deal, TX
- Planting date: May 21, 2018
- Cultivars: Paymaster PM HS26 (1990s)
  Fibermax FM 958 (2000s)
  Deltapine DP 1646 (2010s)
- Fertilizers: 112 kg N ha^{-1} (40% pre-plant, 60% at 50 days after planting [DAP]), 90 kg P ha^{-1} (100% pre-plant), and 30 kg K ha^{-1} (100% pre-plant)
- Total in-season irrigation: 360 mm (sub-surface drip irrigation)
- Total seasonal rainfall: 191 mm
- Sampling dates: 30, 60, 90, and 120 DAP
- Tissues analyzed: Leaves, stems, squares, flowers, burs (immature bolls at 90 DAP; burs from mature bolls at 120 DAP), seeds
- Statistical analysis: Generalized linear mixed model procedure (PROC GLIMMIX, SAS Enterprise Guide 9.4)

Results and Discussion

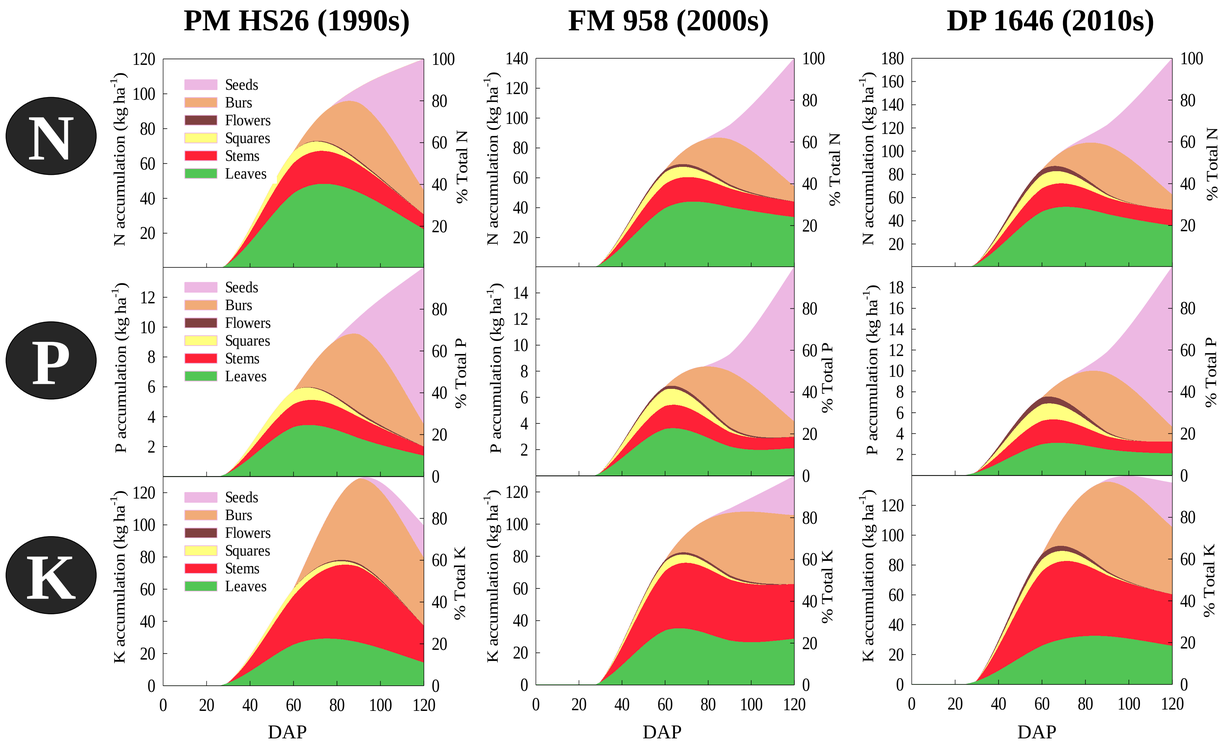

Figure 1. Nutrient partitioning in the different organs of PM HS26, FM 958, and DP 1646 grown at New Deal, TX in 2018. Note that the scale of the accumulation (left y-axis) differs among cultivars.

- The partitioning of nutrients varies among developmental stages and different cultivars (Figure 1).
- The focus of the plant early in the season is in expansion of vegetative growth. This is reflected in the high N, P, and K accumulation in leaves and stems.
- As the plant transitions to the reproductive stage, the accumulation of nutrients towards leaves and stems plateaus, and begins rising in the fruit tissue.
- The differences in patterns of accumulation in more modern cultivars reflect the differences in nutrient requirements to produce yield that reaches a cultivar's potential.
- For example, greater percentage of P was accumulated in burs at early boll development, which was then later utilized by the developing seed.

Table 1. Comparison of crop growth rate and seed cotton yields between cultivar developed prior to 1990 and modern cultivars tested in 2018.

At maximum crop growth rate:	**1990 report**	**2018 report**
Accumulated heat units ($GDD_{°C}$)	500-800	800-1100
Percent of total dry matter	28-38	36-44
Mean lint yield (kg ha^{-1})	839	1457 b (PM HS26) 1744 a (FM 958) 1709 a (DP 1646)

Means of lint yield in 2018 annotated by a common letter are not significantly different at α=0.05.

Table 2. Mean uptake of N, P, and K per unit of lint produced of three modern cotton cultivars grown at New Deal, TX in 2018.

	1990 report	**2018 report**
Mean N uptake per 100 kg lint	**19 kg N ha^{-1}**	**28 kg N ha^{-1} (PM HS26)** **24 kg N ha^{-1} (FM 958)** **25 kg N ha^{-1} (DP 1646)**
Mean P uptake per 100 kg lint	**2.5 kg P ha^{-1}**	**2.9 kg P ha^{-1} (PM HS26)** **3.5 kg P ha^{-1} (FM 958)** **2.6 kg P ha^{-1} (DP 1646)**
Mean K uptake per 100 kg lint	**15 kg K ha^{-1}**	**29 kg K ha^{-1} (PM HS26)** **33 kg K ha^{-1} (FM 958)** **25 kg K ha^{-1} (DP 1646)**

- Growth and development of cotton are temperature-dependent. The growing environments prior to 1990 were cooler than in the recent years. Greater heat unit accumulation of newer cultivars may be responsible for optimal biomass production which translated to increased yield (Table 1).
- There were noticeable increases in the mean nutrient uptake per unit of lint produced in 2018 compared to 1990 (Table 2).
- Newer cultivars have better efficiency in utilizing nutrients to create more yield as shown by the lower amount of a nutrient DP 1646 requires for producing lint.
- This alludes to the enhanced efficiency of modern cultivars in converting nutrient uptake and resource pools to yield production.

Conclusions

Modern cotton cultivars show a higher accumulation of heat units, increased yields, and significant deviation in nutrient uptake dynamics compared to older cultivars. The last point being the most evident during boll development. More importantly, the results also highlight the remarkable improvements in modern cotton cultivars during the past few decades. This research is important for re-evaluating the optimal nutrient inputs for farmers and producers, especially since new cultivars are released regularly, and environmental conditions change continuously.

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