

Popcorn and Field Corn Response to Nitrogen Fertilizer (2023-24) – Purdue Univ.
Dan Quinn, Ph.D.

Extension Corn Specialist

Purdue University

 Email: djquinn@purdue.edu
Narciso Zapata

M.S. Graduate Research Assistant

Purdue University

 Email: nzapatab@purdue.edu

Location (s): 2023 research locations included: Purdue University Agronomy Center for Research and Education (ACRE). West Lafayette, IN. Blann Farms, Oaktown, IN. and Scott Farms, Delphi, IN. 2024 research locations included: Pinney Purdue Agricultural Center (PPAC), Wanatah, IN. Purdue University Agronomy Center for Research and Education (ACRE). West Lafayette, IN. Strasburger Farms, West Lafayette, IN and the Southeast Purdue Agricultural Center, Butlerville, IN.

Location Descriptions:

Research trial treatment designed included randomized completed block designs with 4 - 5 replications. Plot size measured 30 - 40 ft wide (12 - 16, 30-inch corn rows) x the length of the field. Corn planting dates ranged from May 15 – May 26, 2023. Targeted population was 34,000 seeds/ac and the hybrid used was Weaver W2021 or Vogel VYP316 (West Lafayette, On-Farm 2024). Nitrogen fertilizer was applied either as 28% UAN or 32% UAN at all locations and was coultter-injected sidedress at all locations at ~V5 growth stage. Grain yield was harvested from the center 4 - 12 rows using commercial combines with calibrated yield monitors or small-plot combines equipped with a HarvestMaster weight system. Plant samples were taken at the V8, R1, and R6 growth stages to track aboveground plant nutrient uptake difference between popcorn and field corn. In addition, grain samples were taken prior to harvest for quality, popping, and kernel specific data.

Yield Response to Applied Nitrogen Fertilizer (2023):

Table 1. Quadratic plateau regression analysis parameters and calculated agronomic optimum nitrogen fertilizer rates (AONR) and yields obtained at the calculated AONR values for *popcorn* research trials. West Lafayette, Delphi, and Oaktown, IN. 2023.

Location	Model†	Regression Parameters			AONR	YAONR†
		Intercept	Linear Coefficient	Quadratic Coefficient		
West Lafayette	QP	3804.3	53.97	-0.203	132.67 lbs N ac ⁻¹	7384.34 lbs ac ⁻¹
Delphi	QP	5486.2	14.65	-0.045	162.34	6675.63
Oaktown	QP	2861.3	18.79	-0.069	134.43	4125.01

† QP, quadratic-plateau regression model; YAONR, popcorn grain yield at the agronomic optimum N rate (AONR).

Plant Matter Dry Biomass and Nutrient Uptake Data (Popcorn vs. Dent Corn; 2023 and 2024)

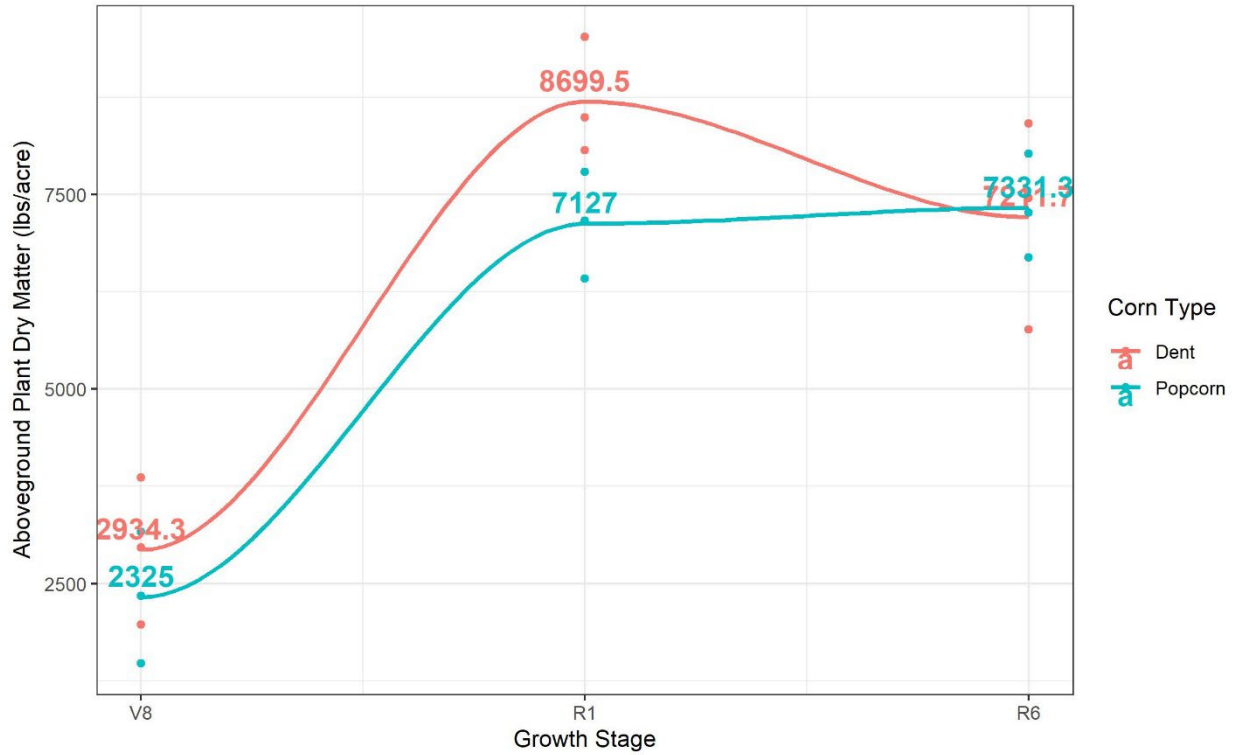


Figure 1. Total Dent and Popcorn whole plant dry matter production (leaf blades, stalk, and leaf sheaths) from growth stage V8 to physiological maturity (R6). Different color lines illustrate the uptake pattern and total differences between corn types grown within the same environment. 2023-24.

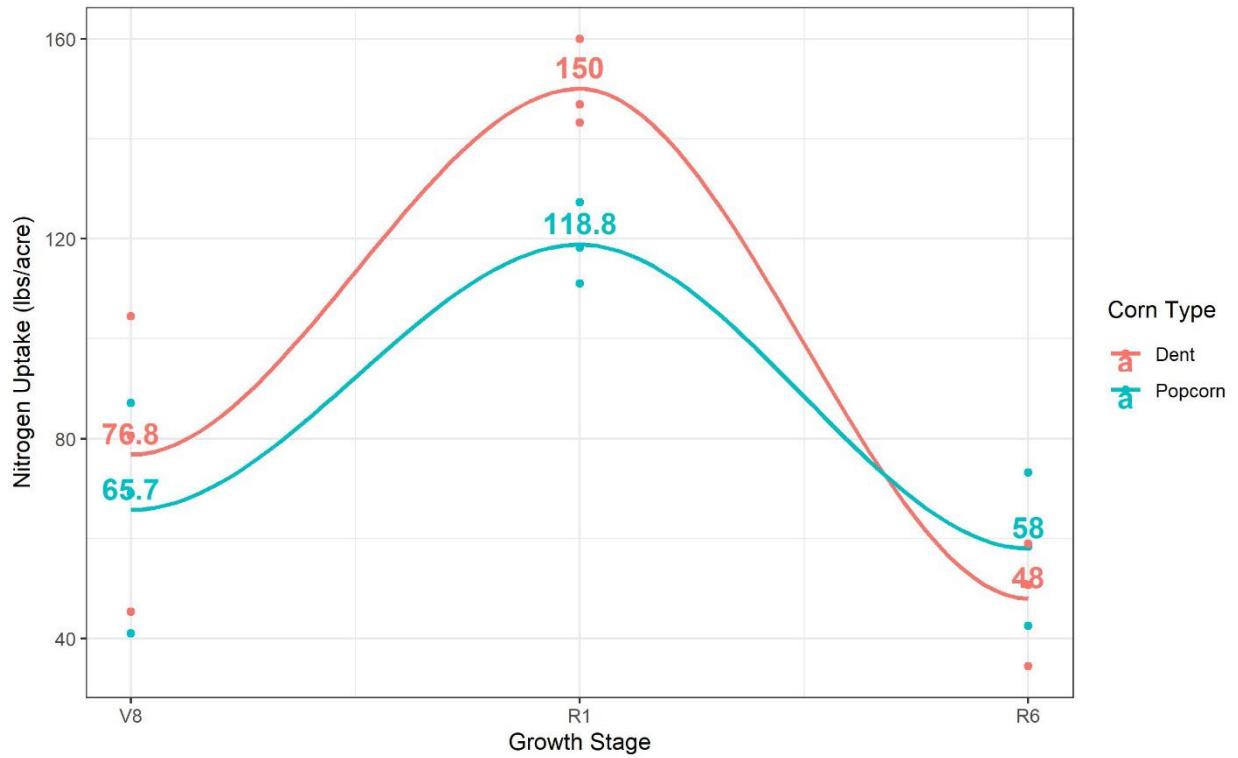


Figure 2. Total Dent and Popcorn whole plant nitrogen uptake (leaf blades, stalk, and leaf sheaths) from growth stage V8 to physiological maturity (R6). Different color lines illustrate the uptake pattern and total differences between corn types grown within the same environment. 2023-24.

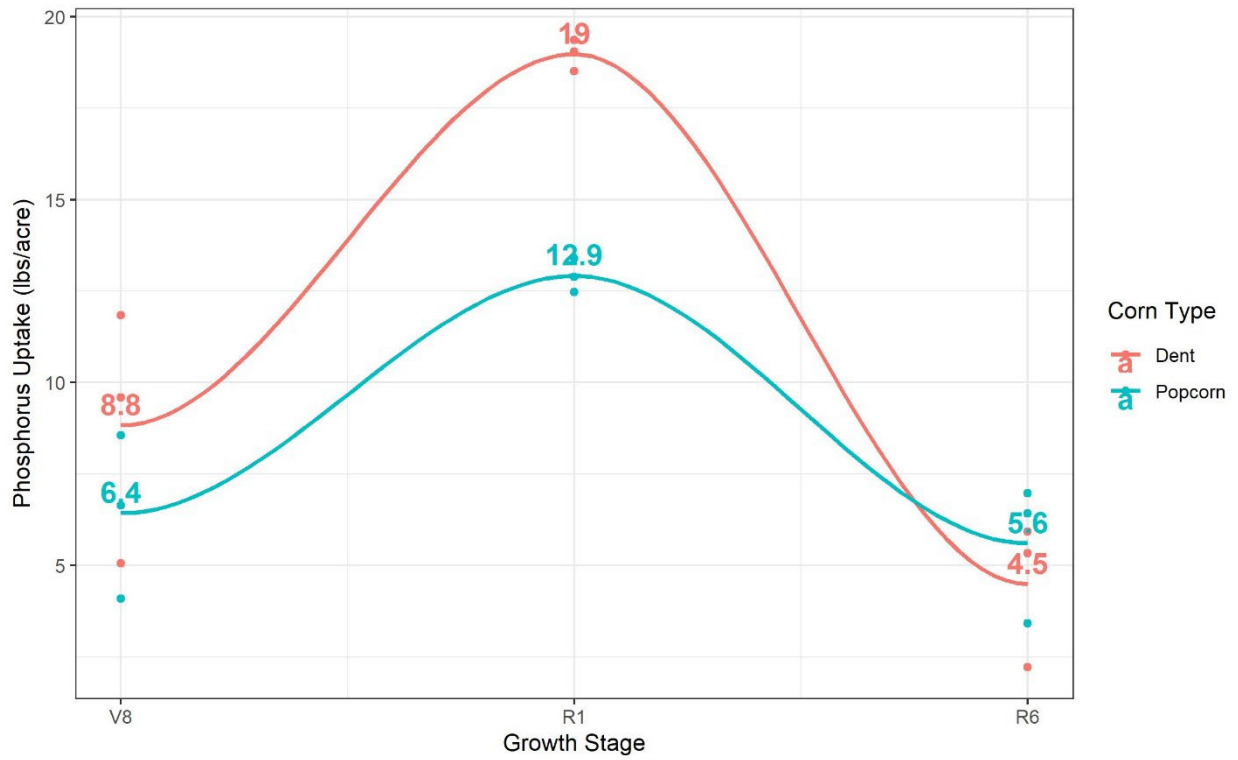


Figure 3. Total Dent and Popcorn whole plant phosphorus uptake (leaf blades, stalk, and leaf sheaths) from growth stage V8 to physiological maturity (R6). Different color lines illustrate the uptake pattern and total differences between corn types grown within the same environment. 2023-24.

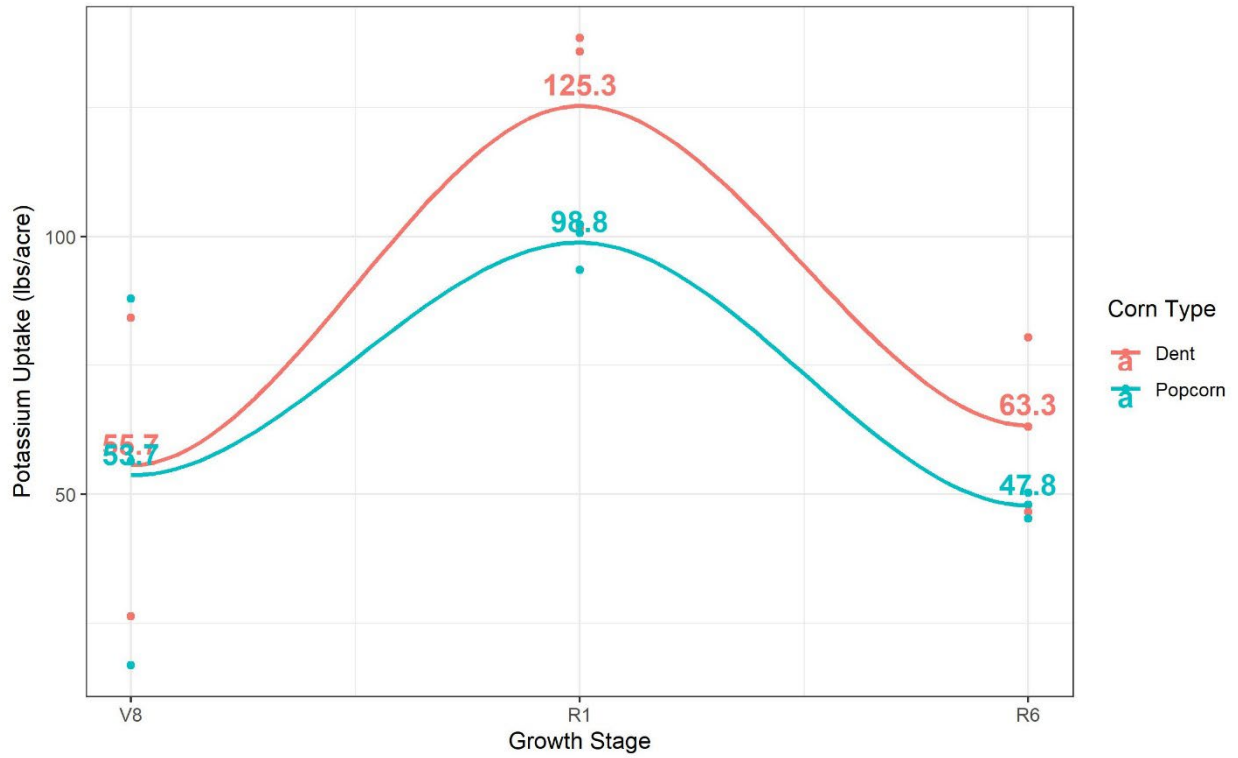


Figure 4. Total Dent and Popcorn whole plant potassium uptake (leaf blades, stalk, and leaf sheaths) from growth stage V8 to physiological maturity (R6). Different color lines illustrate the uptake pattern and total differences between corn types grown within the same environment. 2023-24.

Post-Harvest Popcorn Kernel Data (2023 and 2024)

Table 5. Popcorn mushroom %, butterfly %, kernel count, and expansion in response to applied nitrogen (N) fertilizer rates. **2023.**

N Fertilizer Rate	Mushroom	Butterfly	Kernel Count	Expansion
-- lbs N ac ⁻¹ --	%	%	--- k/10g ---	--- cc/g ---
0	37.5 b*	62.5 a	52.0 a	40.8 c
60	38.5 b	61.5 a	45.0 b	43.5 ab
120	38.8 b	61.2 a	44.2 b	44.0 a
180	45.7 a	54.3 b	42.7 b	43.3 ab
240	44.6 a	55.5 b	44.9 b	41.8 bc

*Mean values within each individual parameter/column that do not contain the same letter are statistically different ($P < 0.1$).

Table 6. Popcorn mushroom %, butterfly %, kernel count, and expansion in response to applied nitrogen (N) fertilizer rates. **2024.**

N Fertilizer Rate	Mushroom	Butterfly	Kernel Count	Expansion
-- lbs N ac ⁻¹ --	%	%	--- k/10g ---	--- cc/g ---
0	21.1 c	78.9 a	50.9 a	41.9 b
60	22.2 bc	77.8 ab	45.8 b	44.4 a
120	25.6 ab	74.4 bc	45.0 b	45.1 a
180	23.2 bc	76.9 ab	45.1 b	44.5 a
240	26.9 a	73.2 c	46.2 b	44.9 a

*Mean values within each individual parameter/column that do not contain the same letter are statistically different ($P < 0.1$).

Table 7. Quadratic regression analysis parameters and calculated maximum expansion and the optimum nitrogen fertilizer rate at which maximum expansion was achieved. **2023-24.**

Year	Regression Parameters					Max Expansion
	Model†	Intercept	Linear Coefficient	Quadratic Coefficient	Optimum Expansion N Rate	
					lbs N ac⁻¹	
2023	Q	40.9	0.04	-0.001	126.1	44.1
2024	Q	42.2	0.04	-0.001	168.1	45.2
All	Q	41.8	0.04	-0.001	148.9	44.8

† QP, quadratic model

Preliminary Conclusions 2023 and 2024:

- Agronomic optimum nitrogen rate for popcorn ranged from 132 - 162 lbs N/ac based on location in 2023 and 133 – 170 lbs N/ac based on location in 2024. In addition, when compared in the same environment, popcorn required 15% less total N fertilizer in order to maximize yield in comparison to dent corn (Table 4).
- Popcorn whole plant nutrient uptake for N, P, and K followed similar growing season patterns as dent corn, yet fewer total nutrients were required within the entire plant. Overall, the results suggest lower total nutrient requirements are required to optimized popcorn production. However, popcorn observed less total aboveground biomass reduction from R1 to R6 as dent corn and maintained higher N and P content in aboveground plant dry matter at maturity. Results are likely due to reduced nutrient remobilization from vegetative tissue to the grain following pollination, resulting in higher N and P levels in the plant matter.
- Nitrogen fertilizer rate had an impact on mushroom%, butterfly%, kernel size, and expansion in both 2023 and 2024 (Table 5 and 6). Overall, results observed higher mushroom % as N fertilizer rate increased in both years. In addition, results suggest either an expansion decrease (2023) or plateau (2024) as N fertilizer rate increases. In 2023, the N fertilizer rate in which expansion was maximized was 126 lbs N/ac and in 2024 the value was 168 lbs N/ac. Across all site-years, expansion was maximized at 148 lbs N/ac, which matches similarly to the optimum N fertilizer rate for popcorn yield across years and locations.
- Across all years and locations, preliminary results observed 21% lower whole plant matter N uptake at the R1 growth stage for popcorn in comparison to dent corn. In addition, across all locations with direct comparisons of popcorn and dent corn within the same environment, optimum N rate for popcorn averaged ~40 lbs N/ac lower for popcorn.