PURDUE UNIVERSITY | Corn Agronomy

2023 Popcorn and Field Corn Response to Nitrogen Fertilizer – Purdue Univ.

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Location (s): Purdue University Agronomy Center for Research and Education (ACRE). West Lafayette, IN. Blann Farms, Oaktown, IN. and Scott Farms, Delphi, IN. An additional trial was planned for Farmland, IN. in 2023, yet was unable to execute due to delayed planting resulting in a reduction in contracted popcorn acres and logistical issues. *Research trial locations will be expanded in 2024 and 2025.*

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. Nitrogen fertilizer was applied either as 28% UAN or 32% UAN at all locations and was coulter-injected sidedress at all locations at ~V5 growth stage. Grain yield was harvested from the center 8 - 12 rows using commercial combines with calibrated yield monitors. Plant samples were taken at the V8, R1, and R6 growth stages to track 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. Dent and Popcorn yield and agronomic efficiency (AE) in response to applied total nitrogen (N) fertilizer rates. West Lafayette, IN 2023.

Corn Type	Total N Fertilizer Rate	Yield	AE[§]
	--- lbs/ac ---	--- bu/ac ---	--- lbs ---
Dent	0	146.2 d	-
	60	228.5 c	76.8 a
	120	256.8 b	51.6 b
	180	268.1 ab	37.9 c
	240	272.5 a	29.5 d
	--- lbs/ac ---	--- lbs/ac ---	--- lbs ---
Popcorn	0	3808.9 c	-
	60	6293.4 b	41.4 c
	120	7400.1 a	29.9 d
	180	7302.3 a	19.4 e
	240	7430.3 a	15.1 e

§ Agronomic Efficiency, AE. Total lbs of grain harvested per lb of N fertilizer applied. Calculated as (yield – yield at 0 N)/N fertilizer rate applied). AE is analyzed across corn types to compare corn type differences and mean values within the same corn type and do not contain a similar letter are statistically different (P<0.1). Grain yield is

separated by corn type due to discrepancies in units used for grain yield and discrepancies in total yield levels. Any mean yield values within each individual corn type that do not contain the same letter are statistically different (*P*<0.1).

Table 2. Popcorn yield response to applied total nitrogen (N) fertilizer rates. Delphi, IN 2023.

Corn Type	Total N Fertilizer Rate	Yield
	--- lbs/ac ---	--- lbs/ac ---
Popcorn	70	6331.7 b
	150	6668.7 a
	180	6627.1 a
	220	6678.5 a
	260	6635.2 a

*Mean yield values within each individual corn type that do not contain the same letter are statistically different (*P*<0.1).

Table 3. Popcorn yield response to applied total nitrogen (N) fertilizer rates. Oaktown, IN (Irrigated; significant lodging issues observed in 2023).

Corn Type	Total N Fertilizer Rate	Yield
	--- lbs/ac ---	--- lbs/ac ---
Popcorn	50	3638.3 b
	100	4040.3 ab
	150	4076.9 ab
	200	4149.8 a

*Mean yield values within each individual corn type that do not contain the same letter are statistically different (*P*<0.1).

Table 4. 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.

Location	Regression Parameters				AONR	YAONR†
	Model†	Intercept	Linear Coefficient	Quadratic Coefficient		
					lbs N ac^{-1}	lbs ac^{-1}
West Lafayette	QP	3804.3	53.97	-0.203	**132.67**	7384.34
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).

Nutrient Uptake Data (Popcorn vs. Dent Corn)

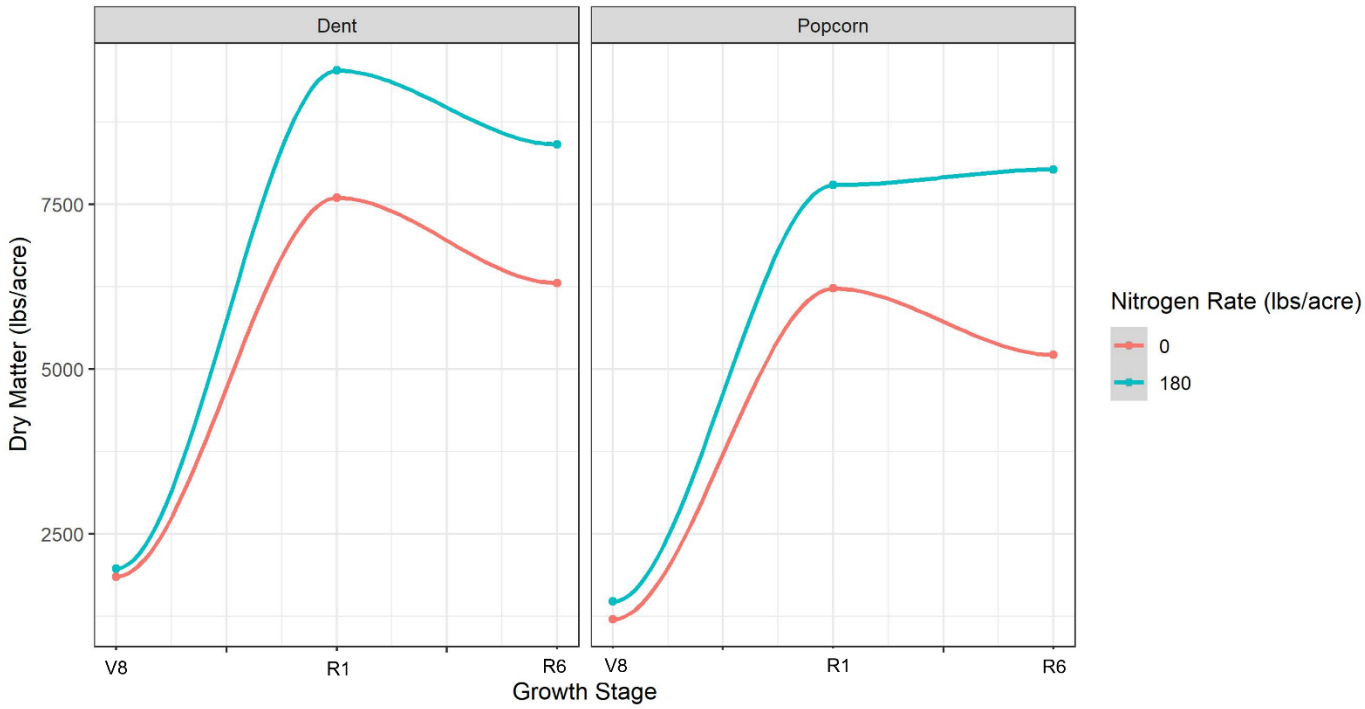

Figure 1. Total Dent and Popcorn whole plant dry matter production (leaf blades, stalk, and leaf sheaths) from growth stage V8 to physiological maturity (R6). Different color lines illustrate the uptake pattern and total differences between plots with N fertilizer applied and plots without N fertilizer applied.

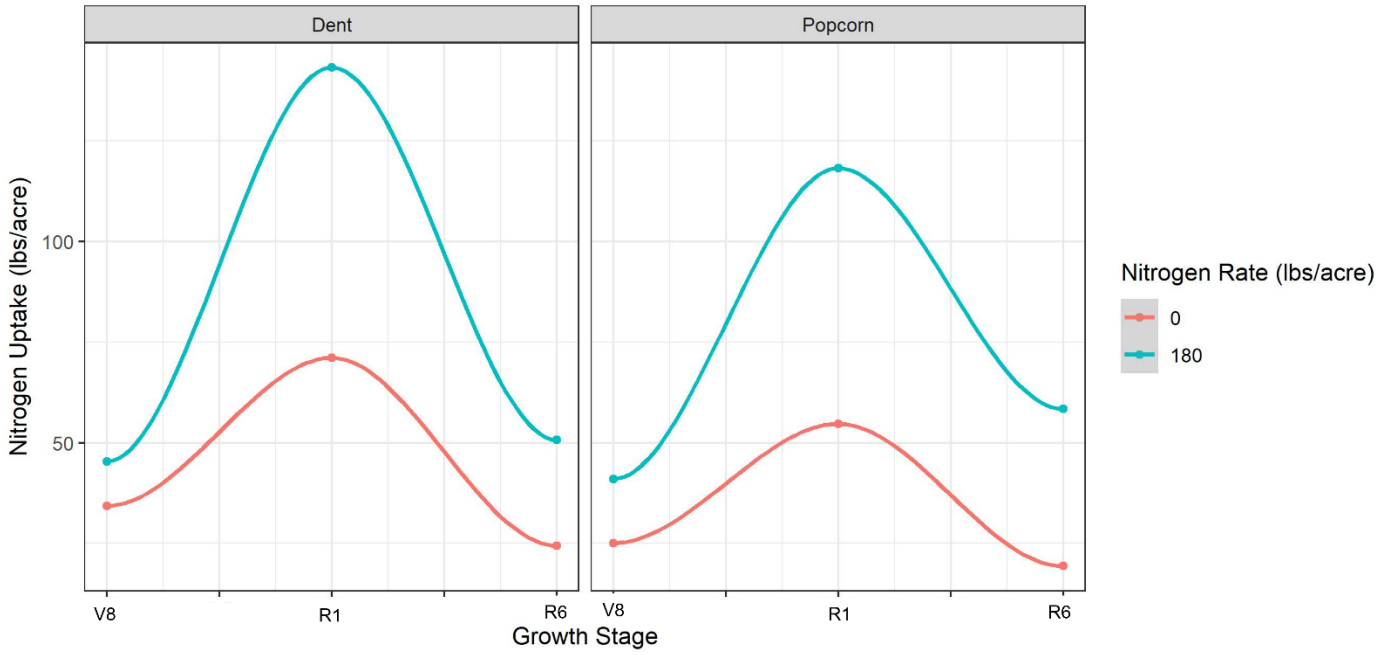

Figure 2. Total Dent and Popcorn whole plant nitrogen uptake (leaf blades, stalk, and leaf sheaths) from growth stage V8 to physiological maturity (R6). Different color lines illustrate the uptake pattern and total differences between plots with N fertilizer applied and plots without N fertilizer applied.

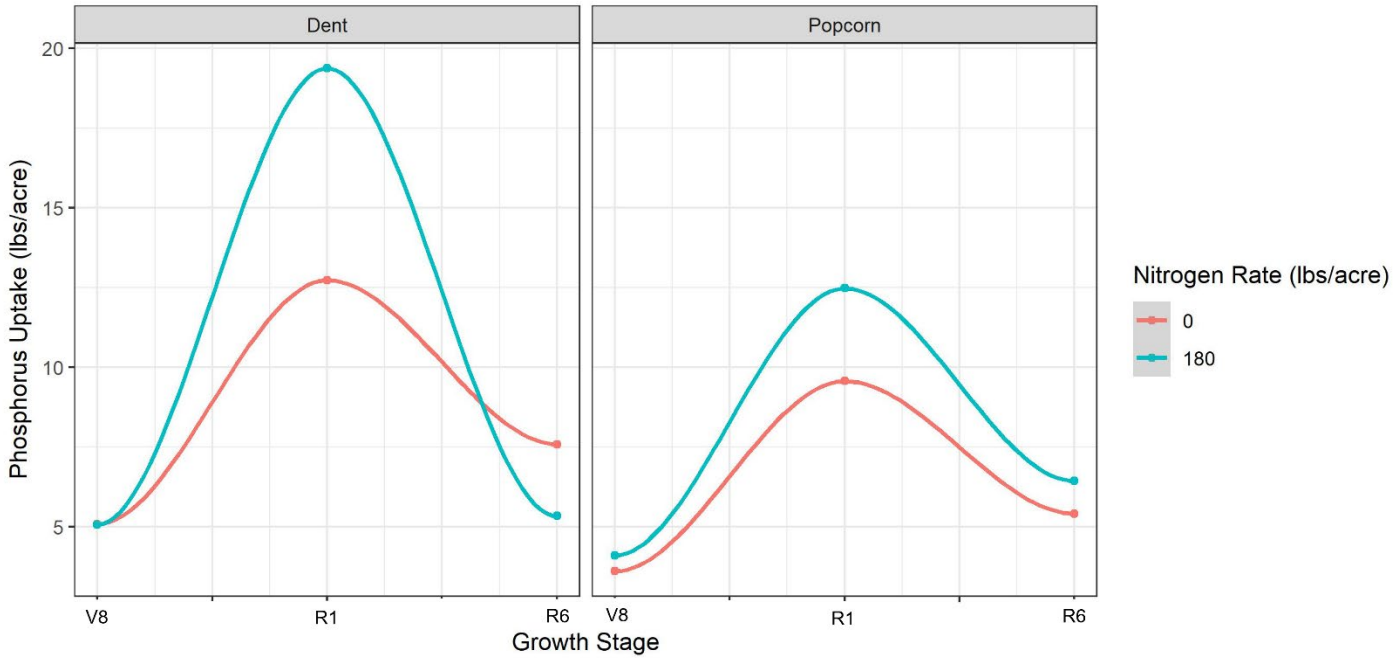

Figure 3. Total Dent and Popcorn whole plant phosphorus uptake (leaf blades, stalk, and leaf sheaths) from growth stage V8 to physiological maturity (R6). Different color lines illustrate the uptake pattern and total differences between plots with N fertilizer applied and plots without N fertilizer applied.

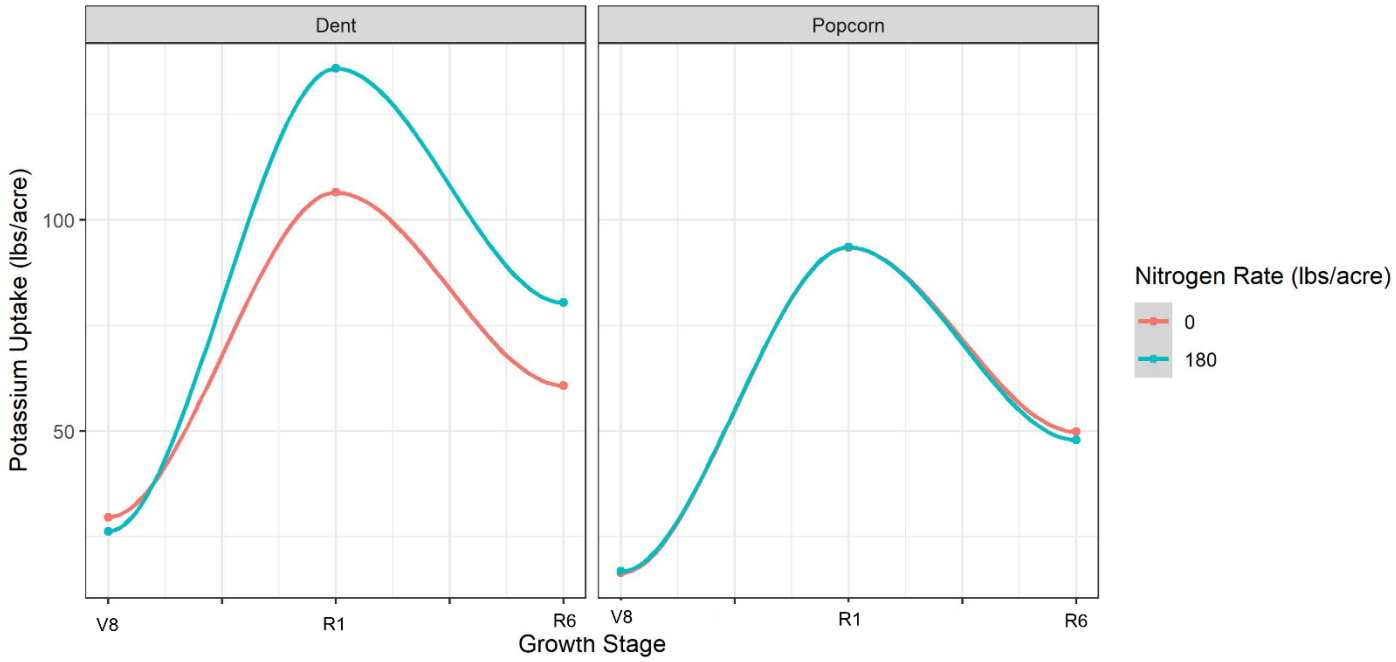

Figure 4. Total Dent and Popcorn whole plant potassium uptake (leaf blades, stalk, and leaf sheaths) from growth stage V8 to physiological maturity (R6). Different color lines illustrate the uptake pattern and total differences between plots with N fertilizer applied and plots without N fertilizer applied.

Post-Harvest Popcorn Kernel Data

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

N Fertilizer Rate	Mushroom	Butterfly	Kernel Size	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).

Preliminary Conclusions 2023:

- Agronomic optimum nitrogen rate for popcorn ranged from 132 - 162 lbs N/ac based on location. 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).

- When compared across N rates applied, dent corn can produce more lbs of grain per lb of N fertilizer applied than popcorn when grown in the same environment. On average across N rates applied, dent corn produces ~48 lbs of grain for each additional lb of N fertilizer applied, whereas, popcorn produces ~26.5 lbs of grain for each additional lb of N fertilizer applied (Table 1).

- 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.

- Nitrogen fertilizer rate had an impact on mushroom%, butterfly%, kernel size, and expansion (Table 5). Preliminary results suggests fertilizer rates may impact kernel parameters and popping characteristics.

Trial Adjustments – 2024

- Need to move more of the trials to research farms (better control of treatments applied, easier to obtain necessary data). Research farms also allow a treatment with 0 N fertilizer (challenging to have a farmer go this low) which is important for NUE data and calculations, and more accurate AONR calculations. Also, total N rates can be difficult to standardize across different farms due to different pre-plant and starter application rates and methods.

- Need to adjust N fertilizer rates that were applied on the on-farm trials (preliminary N rates for on-farm trials were too high, designated by the popcorn board).

- Continue trial for an additional 2-3 years. 2023 was primarily a learning year, more data to come in the future.

- Research trial will be expanded in 2024 and 2025 (5 locations secured for 2024).