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Research article

Nitrogen Uptake at Different Growth Stages of Corn and Its Effect on Important Yield Parameters

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Abstract: Nitrogen is the primary nutrient governing corn yield. This study compares the contrasting nitrogen dynamics of open-pollinated (OPV) and hybrid corn varieties and their consequential impact on overall yield. However, limited research exists comparatively evaluating the nitrogen uptake and utilization efficiency of these varieties under uniform fertilization rates across distinct growth stages. The study employed a Randomized Complete Block Design (RCBD) with three replications, and all treatment plots received the same fertilizer rate to guarantee unbiased experimental results. All collected data were analyzed using the Statistical Package for the Social Sciences (SPSS) and the Statistical Tool for Agricultural Research (STAR) software. These analyses include One-way Analysis of Variance, Independent Sample T-tests, and Pearson's correlation. The results show that nitrogen uptake in hybrid corn declined gradually and steadily across all growth stages (V8: 3.17%, R1: 2.92%, R3: 2.88%, and R5: 2.27%), contrasting with the fluctuating absorption pattern of the OPV. This superior N management is supported by Nitrogen Utilization Efficiency (NUtE), in which the hybrid (31.55 ± 1.36) achieved a higher NUtE than the OPV (28.09 ± 1.38). The two varieties exhibited a statistically significant difference in N uptake at the R1 stage ($p = 0.048$), with the hybrid maintaining a higher N concentration (2.92%) than the OPV (2.58%). Interestingly, OPV N uptake at R1 exhibited a strong correlation with kernel weight (0.638), unshelled weight (0.676), ear weight (0.643), and grain yield (0.576), but showed the inverse trend for hybrid corn. These contrasting results confirm that the OPV exhibits lower nitrogen uptake efficiency while the hybrid displays rapid nitrogen absorption, necessitating precision, variety-specific fertilization strategies for yield and environmental stewardship.

Keywords: Nitrogen content; nitrogen utilization efficiency; hybrid corn; open-pollinated variety (OPV)

1. Introduction

Corn (*Zea mays* L.) is globally recognized as a fundamental staple crop, with annual production exceeding 1 billion tons, making it one of the most consumed grains worldwide [1]. As a major cereal crop, corn plays a fundamental part in Philippine agriculture. In Visayas and Mindanao, 20% of the population relies on it as a staple food, showcasing its significance for the nation's economic and food security [2]. Despite its importance, corn production, along with that of other cereals, is linked to environmental concerns, accounting for around 30% of all synthetic nitrogen (N) fertilizers used worldwide in crop production [1].

Nitrogen (N) is the primary nutrient that determines the final grain output of corn [3]. An adequate N supply is essential, as it enhances photosynthetic rate and prolongs leaf functional life, thereby positively influencing grain filling and yield [4]. However, the global use of nitrogen fertilizer has escalated significantly and has the potential to increase four to five times by 2050, with developing nations accounting for two-thirds of this growth [5]. This trend results in the excessive and disproportionate application of chemical fertilizers, often utilized to maximize yields and alleviate food insecurity [6, 7]. According to [8], nearly half of the nitrogen fertilizer input isn't consumed by crops and is instead released into the environment through gas emissions or waterbody pollution. For instance, inefficient nitrogen use results in significant environmental contamination through surface runoff, denitrification, leaching, and volatilization [9].

The government has been implementing various corn varieties, including hybrids, genetically modified varieties, and open-pollinated varieties (OPVs) [10-12]. Each corn variety absorbs nitrogen differently, and its nitrogen demand changes as it matures. What's more, how corn reacts to applied nitrogen fertilizer isn't fixed; it shifts quite a bit depending on the variety, the location where it's planted, and the presence of other available nutrients [13]. Therefore, recognizing these varying nitrogen requirements is essential, especially since some varieties inherently possess superior efficiency, requiring less N to achieve maximum output. This study investigates the performance of an open-pollinated variety (OPV) relative to a hybrid corn variety with modern genetic traits, comparing their N absorption and capacity to convert absorbed N into grain yield. Nitrogen Utilization Efficiency (NUtE) is defined as the plant's capacity to convert the N already absorbed into economic yield [14]. Limited information exists comparing the N uptake and utilization efficiencies of OPV and hybrid corn varieties under uniform fertilizer regimes, particularly within tropical field conditions. Understanding these varietal differences in N assimilation across growth stages remains a major gap that constrains precise nitrogen management in maize production.

Addressing these differences is crucial for sustainable agriculture, helping farmers optimize fertilizer application and achieve higher yields, lower operational costs, and reduced environmental impact. The primary aim of this study is to analyze the total nitrogen content in two corn varieties during their vegetative and reproductive stages. Specifically, it intends to compare the Nitrogen content and N utilization Efficiency (NUtE) of OPV and hybrid corn varieties, determine the growth stages when nitrogen assimilation is highest for both, measure yield components across the two varieties, and investigate the relationship between N content and key yield parameters.

2. Materials and Methods

2.1 Location

The study was conducted at the production farm of Cebu Technological University–Barili Campus, located at 10°7'56" N and 123°32'56" E. The experiment spanned four months, from October 2024 to January 2025. The experimental site measured approximately 50 m^2, and meticulous preparation ensured optimal conditions for crop growth. Furthermore, the soil analysis conducted by Puyod et al. [15] in the same experimental area indicated that the soils have a high clay content, ranging from 46-70%, which provides a water-holding capacity of more than 40%.

2.2 Planting Materials

The experiment utilized two genetically distinct corn varieties: an open-pollinated variety, IPB Var 11 ck, and a hybrid variety, 1038B339-44, with advanced genetic traits.

2.3 Field Preparation and Planting

A systematic approach was established. Initially, plowing was done after the previous crop was harvested to prevent weed growth and enrich the soil with organic matter. Thereafter, to provide an improved soil surface for planting operations, harrowing was carried out to create a fine seedbed and reduce clodding in the field. The last step was furrowing, which involved creating hills 0.25 meters apart and rows 0.75 meters apart throughout the study area. The study setup included three blocks, each 5 m long and 2.25 m wide, separated by 1 m-wide alleyways to minimize interaction effects and promote uniformity. As soon as the area was laid out, the study began. Lastly, to attain a 100% germination rate, two to three seeds were sown in each hill.

2.4 Experimental Design and Treatments

The experiment was set up with three replications using a Randomized Complete Block Design (RCBD) to ensure reliable results. Fertilizer was applied equally across all treatment plots to maintain consistent nutrient levels and avoid bias during analysis. This allows a comparative assessment of their nitrogen uptake and its potential influence on yield.

2.5 Fertilizer Application

One week before sowing, organic fertilizer (Microbial Compost) was applied to the soil as a basal nutrient source. Subsequently, a split application of commercial nitrogen-rich fertilizers was implemented. The first split was applied 15 days after planting (DAP) with complete fertilizer (14-14-14), followed by the second split at 30 DAP with a mixture of complete and urea fertilizer (46-0-0). These early applications ensured the plants received adequate nitrogen during their vegetative growth stage. Additionally, a third top-dress application of complete fertilizer and potash was applied at 45 DAP to support reproductive development. All fertilizer amounts adhered to the recommended application rates for the area, ensuring proper nutrient management.

2.6 Thinning and Weeding

Thinning was carried out 12 days after sowing, leaving one healthy seedling per hill. For hills where germination did not occur, healthy seedlings from extra hills were transplanted to fill the gaps. Weeds were promptly removed through hand-weeding to ensure the corn had full access to soil nutrients without competition. Additionally, the soil was hilled up around the base of the plants to enhance plant stability and support growth.

2.7 Destructive Sampling Analysis

The samples were gently extracted from the soil during the cooler parts of the day, either early in the morning or late in the afternoon, to reduce the effects of environmental stress, such as heat and strong sunlight, which can impact the plant's physiological processes. Following their removal, they were carefully rinsed with running tap water to remove any dirt that might have adhered to the roots. Then, a second rinse with distilled water was performed to ensure no tap-water residues or contaminants remained that could affect the nitrogen analysis or introduce unintended variables. The samples were then oven-dried according to the method described by Zhao et al. [9], which involved an initial drying phase at 105°C for 30 minutes, followed by a secondary drying stage at 80°C for 8 hours. Once fully dried, the dry weight was recorded, and the samples were carefully stored in labeled plastic zip-lock bags for total nitrogen analysis.

2.8 Data Collection

Nitrogen Content Analysis. Corn samples from both GMO and OPV varieties were collected at four distinct growth stages (V8, R1, R3, and R5). At each stage, the corn tissue was analyzed using the Kjeldahl method at F.A.S.T. Laboratories.

Ear Weight (g). After harvesting, each part of the corn—the husk, cob, and kernels—was carefully weighed with a digital weighing scale.

Unshelled Weight (g). The husk was carefully stripped away from the corn, revealing the cob and grains. These were then weighed to the nearest gram using a digital scale, ensuring accurate measurements for the analysis.

Shelled Weight (g). The grains were separated from the cob through hand-shelling. Afterwards, each sample was individually weighed.

Moisture Content. The kernels were weighed using a moisture meter, which measures moisture content.

Grain Yield. Computed using this formula.

$$= Grain\ Yield\left(\frac{t}{ha}\right) = \left(SW\ (g)x\ \frac{100-MC}{100-18}\right)x\ (\frac{10,000}{Harvest\ Area\ (m2)})\ \text{x}\ (\frac{1}{1,000,000})$$

Where:

- Grain yield (t/ha) = Grain Yield in tons per hectare
- SW (g) = Total Shelled Weight (g)
- MC = Actual Harvest Moisture (%)
- 18 = Standard Moisture Basis (%)
- 10,000 = Conversion factor from square meters to hectares (1ha=10,000m^2)
- Harvest Area (m2) = actual physical area of the crop rows that were cut, collected, and weighed to obtain the raw yield data.
- 1,000,000 = Conversion factor from grams to metric tons (1t=1,000,000g)

Nitrogen Utilization Efficiency. Computed by following the formula of [16].

$$NUtE = \frac{Grain\ Yield\ (\frac{kg}{ha})}{Total\ N\ Content}$$

Where:

- Grain yield (kg/ha) = Grain Yield in kilograms per hectare
- N Content = Nitrogen Uptake at Reproductive Stage 5

2.9 Statistical Analysis

All collected data underwent a comprehensive, combined statistical analysis using Statistical Package for the Social Sciences (SPSS) and Statistical Tool for Agricultural Research (STAR) software. The initial phase involved a careful examination of nitrogen content in both OPV and hybrid corn varieties, specifically during their vegetative (V8) and reproductive (R1, R3, R5) stages. Using a One-way Analysis of Variance (ANOVA) in STAR software, this preliminary step aimed to detect significant differences in nitrogen absorption as plant development progressed. Following this, independent-samples t-tests were performed in SPSS to directly compare nitrogen content between the hybrid and OPV corn varieties at each distinct growth stage. The same analytical approach was then applied to evaluate several key yield parameters. As a final step, Pearson's correlation analysis thoroughly examined the strength and direction of the relationships between the observed final yield traits and the corresponding nitrogen absorption patterns.

3. Results and Discussion

The findings indicate a variability in nitrogen (N) uptake between the two corn varieties across different growth stages. Nitrogen uptake in hybrid corn peaks during the vegetative stage, reaching 3.17%, thereby promoting the plant's early active growth. As the plant advanced to the reproductive stages, its nitrogen absorption gradually declined, with silking and milking stages showing comparable uptake rates of *2.92%* and *2.88%*, respectively. Subsequently, the dent stage (R5) marks the lowest nitrogen absorption, at 2.27%, indicating it is close to complete maturity. In contrast, OPV corn exhibits a distinct pattern of nitrogen absorption across its growth stages. Nitrogen absorption reaches its maximum during the vegetative stage at *3.40%*, giving the plant the nutrients it requires for rapid early growth. After declining to an average of *2.58%* during the silking phase, uptake increases again during the milking stage to 3.04%, a value similar to that during the vegetative period. As the corn reaches the dent stage, nitrogen absorption declines further, settling at *2.13%*, signaling its progression toward full maturity. Furthermore, the independent sample t-test results (Table 2) showed a statistically significant difference in nitrogen uptake between the two corn varieties at the R1 growth stage ($p = 0.048$). This finding may indicate that the genetic disparities and nitrogen absorption characteristics between the two varieties could affect nitrogen absorption during the early stages of reproductive development. Moreover, no significant differences were observed in the V8, R3, and R5 growth stages (p-values of 0.24, 0.242, and 0.476, respectively).

Table 1. Total Nitrogen Content of OPV and Hybrid Corn Varieties per 100g of Dried Samples.

Source: The First Analytical Services and Technical Cooperative Laboratories

Growth Stages	HYBRID	OPV
V8 (Vegetative)	3.17 [a]	3.40 [a]
R1 (Silking)	2.92 [b]	2.58 [b]
R3 (Milking)	2.88 [b]	3.04 [a]
R5 (Dent)	2.27 [c]	2.13 [c]

Means with the same letter are not significantly different.

Table 2. Independent Sample T-tests Result on Nitrogen Content in Hybrid and OPV corn at V8, R1, R3, and R5.

Growth Stages	Significance (2-tailed)
V8 (Vegetative)	0.240
R1 (Silking)	0.048
R3 (Milking)	0.242
R5 (Dent)	0.476

3.1 Peak N uptake at V8 (Vegetative Stage)

During the vegetative growth phase, both varieties typically exhibit their highest nitrogen (N) uptake rate, a crucial process for establishing substantial aboveground biomass. This pattern is corroborated by the research of Khan et al. [12], which documented that corn exhibits its highest N uptake during the early developmental stages, particularly up to the V8 leaf stage. Likewise, [17] found that leaves and roots function as sinks for N uptake and utilization during the early vegetative stage. Agricultural practices often emphasize fertilizer application between the V6 and V8 stages to align with the plant's peak N requirements. Interestingly, corn can accumulate N beyond its immediate needs during this time, a phenomenon described as "luxury consumption" [18]. The slightly higher N concentration observed in the OPV variety at V8 (3.40%) compared to the hybrid variety (3.17%) may reflect a greater capacity for luxury consumption during this early growth phase. This early-accumulated N functions as a reserve pool, primarily stored in stalks and leaves [16]. This supply provides a buffer against potential N deficiencies and supports grain development and overall plant health if N uptake after silking becomes restricted [18]. The contrasting early nitrogen absorption sets the stage for the different strategies these varieties employ during grain filling.

3.2 Genetic Difference and Acute N stress at R1 (Silking)

The tissue analysis shows that the OPV corn experienced an acute drop in N content, from its vegetative peak of 3.40% to 2.58% at R1. This represents a drastic decline in tissue N during the transition to the most demand-intensive phase of reproduction. This reduction implies that the N supply fails to meet the crop’s peak requirement at the onset of silking. The R1 stage marked the point of greatest physiological and statistical divergence between the two varieties. The independent sample t-test revealed a statistically significant difference in N uptake at R1 ($p=0.048$), the only stage to show such a difference. At R1, the OPV variety demonstrated a sharp decline in tissue N concentration. Conversely, the hybrid variety exhibited a more modest decline to 2.92% N, maintaining a significantly higher relative N status than the OPV variety. The plant's early capacity for substantial nitrogen uptake underscores its effective nutrient utilization strategy throughout its life cycle. However, N deficiency during the critical tasseling and silking stages can substantially increase the risk of crop failure [19]. To satisfy the notable N requirements of grain development, a considerable quantity of N is progressively redistributed from vegetative tissues during the reproductive phase [20]. As evident from the sharp decline in OPV's tissue N (Table 1), an influential decline in N availability likely stressed the plants. This N deficit during R1 in OPV could lead to compromised pollination, reduced kernel formation, and increased kernel abortion, as research has established that successful spikelet development relies on pollination, and severe N stress during this process can impede pollination success [16]. On the other hand, the observed modest decrease in N uptake in hybrid corn at the R1 stage suggests a relative resilience to significant yield loss from N stress at this critical point. A study demonstrated superior nitrogen use efficiency (NUE) and grain yield of Topcross corn compared with open-pollinated varieties (OPVs) under both limited and ample N conditions [21], which may support a broader trend of improved N management in more advanced corn varieties compared with OPVs under stress.

3.3 Compensatory Uptake and Remobilization at R3 (Milking)

The pattern reversed dramatically at the R3 (Milking) stage. The milking stage, characterized by rapid starch accumulation, milky kernel contents, and completed endosperm cell division [26], showed a significant recovery in OPV, increasing its N concentration from 2.58% (R1) back up to 3.04%. Meanwhile, the hybrid variety continued a gradual, stable decline in N content (2.88%). Ultimately, scientific literature confirms that the developing ear's massive N requirements during reproductive stages cannot be met solely through new soil uptake; the plant heavily relies on remobilized N from its stalks and leaves [22]. Since the OPV suffered an acute R1 deficit, its subsequent recovery at R3 must be interpreted, at least in part, as a desperate survival mechanism: the plant aggressively transferred remaining N reserves from its vegetative structures (source organs like stalks and older leaves) to the developing kernels (sink organs) to continue grain filling and survive further growth stages. This aligns with the research of Ruiz et al. [23], showing corn's ability to redistribute remaining stalk nitrogen to the grain. Therefore, the increased nitrogen content observed in OPV at the milking stage likely reflects this enhanced movement and uptake aimed at making up for the earlier deficit during R1 and supporting grain development. While this remobilization demonstrates the corn plant's adaptive capacity, it comes at a physiological cost, often resulting in premature senescence of vegetative tissues. Crucially, because the yield potential (kernel number) was already significantly reduced by the N limitation that occurred at R1, this late-stage N recovery cannot repair the structural yield losses. The resulting weak or negative correlation between R3 N content and final grain yield demonstrates this. Conversely, the nitrogen uptake pattern in the hybrid variety suggests potentially better nitrogen utilization efficiency (NUtE), indicating a more stable and more effective allocation of nitrogen to support critical reproductive stages.

3.4 Overall Superiority in Yield Parameters

The outcomes of this investigation unequivocally demonstrate that the hybrid corn exhibits greater production capacity across nearly all metrics than the OPV. The visual data in Figure 1, where the bar heights for the hybrid variety are consistently greater than those for the OPV, are statistically supported by the Independent Samples T-test results. The hybrid corn demonstrated statistically superior Shelled Weight performance (p=0.000) compared to the Open-Pollinated Variety (OPV). The hybrid achieved a significantly higher weight of 196.10 ± 8.49 g, while the OPV recorded 152.73 ± 6.68 g. Since shelled weight is the primary determinant of final grain mass, this superiority suggests that the hybrid corn was genetically more robust in kernel setting (kernel number). Further supporting the yield difference, the hybrid variety achieved significantly higher Unshelled Weight and Ear Weight. Specifically, the hybrid recorded 227.43 ± 10.32 g (Unshelled Weight) and 243.12 ± 10.63 g (Ear Weight). In comparison, the OPV only yielded 187.79 ± 9.00 g (Unshelled) and 199.36 ± 10.93 g (Ear Weight). These results provide comprehensive proof that the advanced genetics in the hybrid variety successfully translated resources into greater physical biomass in the final harvestable ear structure compared to the OPV. Most importantly, the calculated Grain Yield (t/ha) was statistically superior for the hybrid variety (p=0.004). This finding provides the fundamental justification for the conclusion that the hybrid variety has a substantially higher yield potential under these specific conditions. The only yield parameter that appears to have a counterproductive effect on the hybrid is moisture content. Consistent with our findings, previous research has also documented significant variations in grain moisture content across different corn varieties [24-26]. Furthermore, [27] noted that earlier-maturing cultivars dry their grains more quickly before physiological maturity, while later-maturing ones dry more slowly. Additionally, [28] found that increased nitrogen levels and rice biomass were associated with higher moisture content and a longer time to reach harvest dryness, a pattern also observed in corn [27]. Likewise, [29] reported a connection between larger leaf area (potentially due to higher nitrogen) and greater moisture content in maize. These established findings from other studies support our results, especially given the higher nitrogen utilization efficiency (NUtE) observed in the hybrid corn in this research.

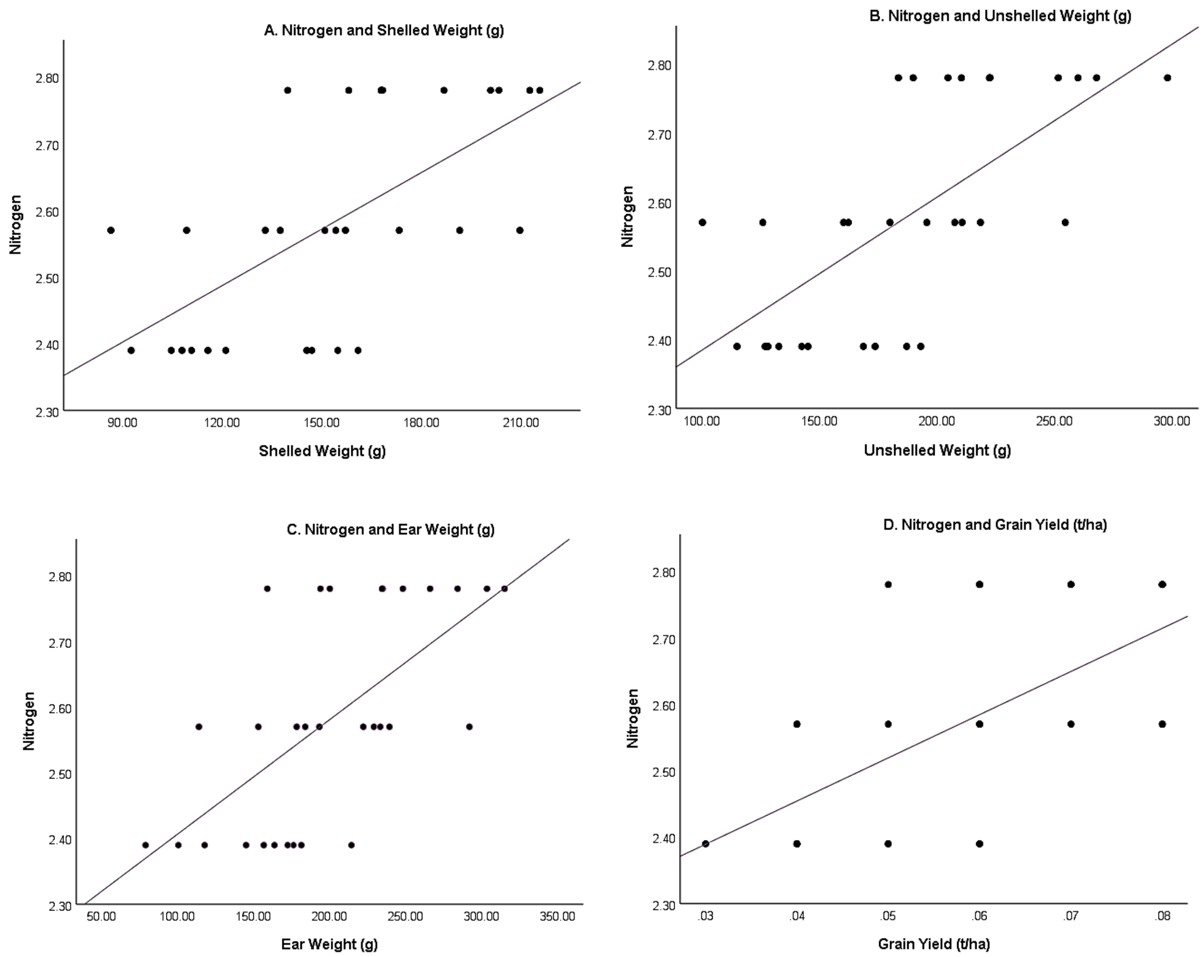

Figure 1. Pearson's correlation analysis showing the relationship between R1 tissue Nitrogen (N) concentration (%) and various yield components in the Open-Pollinated Variety (OPV) corn: A. Shelled Weight (g); B. Unshelled Weight (g); C. Ear Weight (g); and D. Final Grain Yield (t/ha). The positive slope of the trend lines indicates a strong positive correlation between R1 N uptake and final yield output.

Table 3. Corn Yield Parameters and Nitrogen Utilization Efficiency (NUtE) subjected to Independent Sample T-test

Yield Component	OPV	Hybrid	Sig. (2tailed)
Shelled Weight	152.73 ± 6.68	196.10 ± 8.49	0.000
Unshelled Weight	187.79 ± 9	227.43 ± 10.32	0.005
Ear Weight	199.36 ± 10.93	243.12 ± 10.63	0.006
Moisture Content	20.63 ± 0.50	25.67 ± 0.83	0.000
Grain Yield	0.60 ± 0.00	0.07 ± 0.00	0.004
Nitrogen Utilization Efficiency (NUtE)	28.09 ± 1.38	31.55±1.36	0.080

3.5 Superior Nitrogen Utilization Efficiency (NUtE)

NUtE is defined as the ratio of grain weight (yield) to the total amount of nitrogen accumulated in the mature plant. This metric measures the plant's capacity to convert absorbed nitrogen into final economic yield. As Figure 1 shows, the hybrid variety (31.55 ± 1.36) achieved a higher NUtE than the OPV (28.09 ± 1.38). This finding provides direct quantitative support for the view that hybrid corn's superior yield is fundamentally driven by better resource partitioning and conversion efficiency, rather than simply by higher N uptake. The ability to produce greater grain mass per unit of absorbed N mass highlights the hybrid's proactive, controlled genetic management of nitrogen, enabling it to achieve higher yields.

3.6 Positive Relationship of N and R1

Pearson's correlation analysis revealed a strong, positive relationship between nitrogen (N) uptake and yield at the R1 (silking) stage in the OPV. This finding strongly suggests that N supply was a limiting factor at R1. The OPV displayed high sensitivity to N stress at this stage, evidenced by a sharp drop in tissue N from V8 to R1, which subsequently required compensatory N remobilization at R3. Therefore, any variation that resulted in slightly higher tissue N content at R1 directly translated to a measurable increase in final grain output. Under the uniform fertilization regime, the OPV was operating below its N-saturation point, making its yield highly responsive to N availability at R1. Small increases in tissue N due to plot variability made the yield sensitive and directly translated into higher grain output, resulting in the observed positive correlation. Based on these results, the current split fertilizer timing failed to ensure adequate N availability for the OPV during R1. The OPV requires N inputs adjusted to ensure a higher, more stable N level is present leading up to and during R1. This necessitates more targeted, strategic fertilization (better timing) and potentially a higher total N rate to avoid N-limiting stress. In short, the OPV is a reactive, N-demanding variety that needs fertilizer management to be front-loaded and accurately timed to push its N status above the stress threshold, thus unlocking its full yield potential. In contrast, the hybrid variety exhibited an inverse correlation between N uptake and yield across all four growth stages (V8, R1, R3, and R5). This does not indicate poor productivity; instead, it suggests the hybrid variety, which is effective at accumulating N, surpassed its optimal N level for maximizing yield per unit of N absorbed under the current fertilizer inputs. This pattern signals a decline in Nitrogen Utilization Efficiency (NUtE) at very high N uptake levels. As N uptake increases beyond a certain point, its yield plateaus because excess N cannot translate into additional yield, as it has already reached its maximum potential. The same yield plateauing situation was observed in the OPV at the later R3 and R5 stages. This finding is particularly relevant for sustainable farming. It implies that applying the highest possible N rates might not be the most efficient or environmentally sound strategy for this hybrid corn. Excess absorbed N could instead be wasted, contributing to environmental issues through leaching or runoff. The plant maximized its yield potential at a specific N level; absorbing more N did not increase grain yield, so the efficiency of that additional N uptake appeared negative in terms of yield return. While N deficiency negatively impacts productivity, excessive N consumption can also compromise product quality.

Table 4. Pearson's Correlation Analysis Report from SPSS (Open-pollinated Variety)

Yield Component	Pearson Correlation (r)			
	Nitrogen (V8 Stage)	Nitrogen (R1 Stage)	Nitrogen (R3 Stage)	Nitrogen (R5 Stage)
Shelled Weight	-.629	.638	-.236	-.201
Unshelled Weight	-.675	.676	-.288	-.252
Ear Weight	-.615	.643	-.141	-.104
Moisture Content	-.157	.093	-.345	-.346
Grain Yield	-.553	.576	-.139	-.106

Table 5. Pearson's Correlation Analysis Report from SPSS (Hybrid Variety)

Yield Component	Pearson Correlation (r)			
	Nitrogen (V8 Stage)	Nitrogen (R1 Stage)	Nitrogen (R3 Stage)	Nitrogen (R5 Stage)
Shelled Weight	-.254	-.382	-.416	-.349
Unshelled Weight	-.152	-.269	-.315	-.293
Ear Weight	.039	-.081	-.161	-.236
Moisture Content	-.003	-.198	-.316	-.404
Grain Yield	-.254	-.319	-.316	-.219

4. Conclusion

The study conclusively demonstrates that the uniform fertilization regime revealed two fundamentally distinct physiological responses across the two varieties. The Open-Pollinated Variety (OPV) was confirmed as an N-limited, reactive genotype. The sharp decline in N tissue content at the R1 (silking) stage, coupled with a strong positive correlation between N uptake and final yield, provides empirical evidence that the uniform N rate was insufficient and imposed a yield-limiting stress. This stress mandates strategic intervention through improved timing and potentially higher N inputs to realize the OPV's full potential. In contrast, the hybrid variety demonstrated superior yield and high Nitrogen Utilization Efficiency (NUtE). The consistent inverse correlation between N uptake and yield proves that the uniform rate constituted over-fertilization, pushing the variety beyond its efficiency ceiling and leading to luxury N consumption that did not contribute to higher yields. This research confirms that the optimal agronomic strategy for modern, high-efficiency corn varieties is fundamentally different from that required for OPVs, mandating a move toward variety-specific N management.

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