Effect of Different levels and Times of Nitrogen Application on Grain Quality, NPK content~~&Uptakein&~~and UptakeinSweet corn (*Zea mays* L. *saccharata*)

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ABSTRACT

This field experiment conducted during the *rabi* season of 2017-18 at N. M. College of Agriculture, Navsari Agricultural University, Gujarat, aimed to investigate the response of sweet corn (*Zea mays* L. *saccharata*) to different rates and timings of nitrogen application under the south Gujarat conditions. The factorial randomized block design (FRBD) with three replications was employed, considering four nitrogen levels (90 kg/ha, 120 kg/ha, 150 kg/ha, and 180 kg/ha) and four split application treatments (½ basal + ½ at knee height, ½ basal + ¼ knee height + ¼ tasseling, $^{1}/_{3}$ basal + $^{1}/_{3}$ knee height + $^{1}/_{3}$ tasseling, and ¼ basal + ½ at knee height + ¼ tasseling). The results of the study demonstrated that the application of 180 kg/ha nitrogen significantly increased the protein content in grain and fodder (10.51% and 3.88% respectively) and total sugar content (14.96). Additionally, higher NPK uptake and available nitrogen (197.25 kg/ha) and phosphorus (47.53 kg/ha) levels were observed with a 180 kg/ha nitrogen application rate. When nitrogen was applied in three splits, specifically at ¼ basal + ½ at knee height + ¼ tasseling, it resulted in significantly higher protein content in grain and fodder (9.89% and 3.54% respectively), total sugar content (13.65), as well as NPK uptake in grain and fodder and available nitrogen and phosphorus (189.95 kg/ha and 45.84 kg/ha). These findings highlight the importance of nitrogen management in sweet corn cultivation to enhance the nutritional quality and productivity of both grain and fodder. Implementing the optimal nitrogen levels (180 kg/ha) and split application timings (¼ basal + ½ at knee height + ¼ tasseling) can contribute to achieving desirable protein and sugar content, as well as improving NPK uptake and availability of nitrogen and phosphorus.

Keywords:*Nitrogen, Maize, Time of application, Sweet corn*and *Quality*

INTRODUCTION:

Sweet corn (*Zea mays* L.) is a popular and economically significant crop globally, known for its delicious taste and nutritional value. Achieving optimal NPK (nitrogen, phosphorus, and potassium) content, uptake and maintaining grain quality are crucial factors for maximizing the yield and nutritional value of sweet corn. Nitrogen is a vital nutrient for plant growth and plays a key role in enhancing crop productivity, while phosphorus and potassium are essential for various physiological and biochemical processes in plants.

The efficient management of nitrogen fertilizer, including the appropriate nitrogen levels and timing of application, is crucial for ensuring optimal crop growth, yield, nutrient uptake, and grain quality. However, the impact of different nitrogen levels and timing of nitrogen application on NPK content uptake and grain quality of sweet corn has not been extensively studied. Understanding the effects of these factors can provide valuable insights into improving nutrient management practices and enhancing the overall agronomic performance of sweet corn. This research aims to investigate the effect of different nitrogen levels and the timing of nitrogen application on NPK content, uptake and the quality of sweet corn grain. By assessing the NPK uptake, we can gain insights into the nutrient dynamics within the plant and understand how nitrogen levels and timing influence nutrient acquisition. Additionally, evaluating the grain quality parameters such as sugar content, and protein content will provide a comprehensive understanding of how nitrogen management practices affect the end-product quality of sweet corn.

The findings from this study will contribute to the existing knowledge on optimizing nitrogen management strategies for sweet corn cultivation, ultimately enabling farmers to enhance crop productivity, improve nutrient use efficiency, and produce high-quality grain. Moreover, the results will have implications for sustainable agriculture practices, ensuring the efficient utilization of fertilizers while minimizing environmental impacts. Overall, investigating the effects of different nitrogen levels and timing of nitrogen application on NPK content uptake and grain quality of sweet corn will provide valuable insights that can be utilized to optimize nutrient management practices and enhance the economic and nutritional value of this important crop.

MATERIAL AND METHODS

The present study was conducted on plot number E-18 of the College Farm, N. M. College of Agriculture, NAU, Navsari during the *rabi* season of 2017-18. The location is situated 12 km east of the great historical place "Dandi" on the Arabian seashore. The climate of this region is characterized by fairly hot summers, moderately cold winters, and warm humid monsoons with heavy rainfall. Throughout the investigation, the weekly mean maximum and minimum temperatures ranged from 26.6°C to 37.3°C and 10°C to 19.9°C, respectively. The bright sunshine hours varied between 2.5 and 9.8 hours per day during the crop period.The experimental site has a flat topography with dark greyish-brown soil. The soil has medium to poor drainage and good water-holding capacity. The predominant clay mineral found in the soil is montmorillonite. Initial soil analysis data indicated that the experimental site had clay texture and showed low, high, and high ratings for available nitrogen (209.6 kg/ha), phosphorus (40.62 kg/ha), and potassium (384.32 kg/ha), respectively. The soil was slightly alkaline with a pH of 7.9 and normal electrical conductivity of 0.37 dS/m.

The present experiment was designed using a Factorial Randomized Block Design with 16 treatment combinations. Four nitrogen levels were tested: 90 kg/ha (N_1), 120 kg/ha (N_2), 150 kg/ha (N_3), and 180 kg/ha (N_4). Four split application treatments were also applied: ½ basal + ½ at knee height (T_1), ½ basal + ¼ knee height + ¼ tasseling (T_2), 1/3 basal + 1/3 knee height + 1/3 tasseling (T_3), and ¼ basal + ½ at knee height + ¼ tasseling (T_4). Each treatment combination was replicated three times. Phosphorus and potash were applied as basal through SSP and MOP fertilizer, respectively, while nitrogen was applied as urea according to the respective treatments.All observations, growth parameters, and yield parameters were recorded following standard methods. The statistical analysis of the collected data was performed using appropriate procedures described by Panse and Sukhatme (1967) for the experimental design.

RESULTS AND DISCUSSION:

Quality parameters:

Protein content in grain and fodder:

The results presented in Table 1 demonstrate the significant impact of nitrogen levels and different timings of nitrogen application on the protein content of sweet corn grain and fodder. The data clearly shows that higher nitrogen levels lead to increased protein content in both the grain and fodder. The application of nitrogen at 180 kg N/ha (N_4) resulted in the highest protein content in the grain and fodder (10.51% and 3.88% respectively), which was statistically similar to the protein content observed at 150 kg N/ha (N_3). Conversely, the lowest protein content in the grain and fodder (8.65% and 2.87% respectively) was observed with the application of nitrogen at 90 kg N/ha (N_1). The increase in protein content with higher nitrogen levels can be attributed to nitrogen's role as a crucial component in protein synthesis. Nitrogen is essential for the formation of amino acids, the building blocks of proteins. When nitrogen is available in sufficient amounts, plants can efficiently assimilate it and convert it into proteins, resulting in higher protein content in the grain and fodder. These findings are consistent with the studies conducted by Dangariya*et al.* (2017), Naiz*et al.* (2015), and Bhatt (2012).

Furthermore, the timing of nitrogen application also significantly affected the protein content of sweet corn grain and fodder. The treatment that resulted in the highest protein content in the grain and fodder (9.89% and 3.54% respectively) was when nitrogen was applied at ¼ basal + ½ at knee height + ¼ tasseling (T_4). This treatment showed statistically similar protein content to the treatments of $^{1}/_{3}$ basal + $^{1}/_{3}$ knee height + $^{1}/_{3}$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). Providing nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) resulted in the highest protein content. This finding can be attributed to the timing aligning with critical stages of corn growth, such as the vegetative stage (basal), rapid growth stage (knee height), and reproductive stage (tasseling), where the plant's protein synthesis processes are most active. By supplying nitrogen during these stages, the plant can effectively utilize the nutrient for protein production, leading to higher protein content in the grain and fodder. These results are supported by the studies conducted by Bindhani*et al.* (2007) and Naiz*et al.* (2015). However, the interaction effect between nitrogen levels and the timing of nitrogen application was found to be non-significant concerning the protein content in sweet corn grain and fodder.

Total sugar content in grain:

The results presented in Table 1 demonstrate the significant impact of nitrogen levels, time of nitrogen application, and their interaction on the total sugar content in grain. Higher nitrogen levels were found to have a significant influence on the total sugar content. The highest total sugar content of 14.96% was recorded with the application of nitrogen at 180 kg N/ha (N_4), which was statistically similar to the total sugar content observed at 150 kg N/ha (N_3). Conversely, the lowest total sugar content of 10.78% was registered with the application of nitrogen at 90 kg N/ha (N_1). Furthermore, the time of nitrogen application also played a significant role in determining the total sugar content in the grain. The treatment that resulted in the highest total sugar content of 10.76% was when nitrogen was applied at ¼ basal + ½ at knee height + ¼ tasseling (T_4). This treatment showed statistically similar total sugar content to the treatments of $^{1}/_{3}$ basal + $^{1}/_{3}$ knee height + $^{1}/_{3}$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). However, the interaction effect between nitrogen levels and the time of nitrogen application did not exert a significant impact on the total sugar content. The observed increase in total sugar content with higher nitrogen levels can be attributed to nitrogen's role as a crucial component in the formation of amino acids, which are the building blocks of proteins. Amino acids can be converted into sugars through metabolic pathways, and when nitrogen is available in adequate amounts at the right time, plants can allocate the nutrient towards sugar synthesis, leading to higher total sugar content in the grain. Additionally, higher nitrogen levels can enhance the activity of enzymes involved in carbohydrate metabolism, resulting in increased sugar production. These findings are supported by the studies conducted by Sunitha and Reddy (2012) and Akgun and Siyah (2015).

Nutrient studies:

N, P, and K content in grain and fodder:

The data presented in Table 1 regarding the N, P, and K content in grain and fodder clearly indicate that there were no significant differences in the P and K content between the different treatments. However, a significant difference was observed in the N content, which was influenced by both the nitrogen levels and the timing of nitrogen application. The highest N content in both the grain and fodder (1.681% and 0.621% respectively) was recorded with the application of nitrogen at 180 kg N/ha (N_4), and this was statistically similar to the N content observed at 150 kg N/ha (N_3). This suggests that higher nitrogen levels led to increased N content in both the grain and fodder. Furthermore, among the different timings of nitrogen application, the treatment of ¼ basal + ½ at knee height + ¼ tasseling (T_4) resulted in significantly higher N content in the grain and fodder (1.582% and 0.566% respectively). This treatment showed statistically similar N content to the treatments of $^{1}/_{3}$ basal + $^{1}/_{3}$ knee height + $^{1}/_{3}$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling

(T_2). However, no significant interaction effects were observed between nitrogen levels and timing of nitrogen application concerning the N, P, and K content in the sweet corn grain and fodder.

N, P and K uptake by grain and fodder:

The uptake of nitrogen (N), phosphorus (P), and potassium (K) by both the grain and fodder of sweet corn is revealed by the data presented in Table 2, considering the effects of different nitrogen levels, timing of nitrogen application, and their interaction. In terms of the grain, the significance of nitrogen levels on N, P, and K uptake is demonstrated. The highest uptake of N, P, and K by the grain (61.49, 13.74, and 45.66 kg/ha respectively) was observed with the application of 180 kg N/ha (N_4), indicating a positive correlation between nitrogen availability and nutrient uptake. This finding is supported by previous studies conducted by Sahoo and Mahapatra (2007) and Bhatt (2012), which also reported increased nutrient uptake with higher nitrogen levels. The elevated uptake of nitrogen and potassium can be attributed to the promotion of plant growth and development, resulting in higher yields of green cob and green fodder.

Furthermore, the timing of nitrogen application influenced nutrient uptake in the grain. The treatment of ¼ basal + ½ at knee height + ¼ tasseling (T_4) yielded the highest N, P, and K uptake by the grain (57.99, 12.48, and 41.66 kg/ha respectively). This can be attributed to the enhanced nutrient demand during the flowering period, where a consistent and adequate supply of nitrogen fosters optimal nutrient uptake. Kumar *et al.* (2014) also supported this notion, demonstrating that nitrogen supply during the flowering period improves root and shoot development, leading to increased N, P, and K uptake. Therefore, the observed high nutrient uptake with the T_4 treatment can be attributed to the well-timed nitrogen application during the peak nutrient demand stage.

Similar trends were observed for the fodder component. The application of 180 kg N/ha (N_4) resulted in the highest N, P, and K uptake by the fodder (92.51, 22.19, and 124.19 kg/ha respectively), aligning with the findings for the grain. The increased nutrient uptake in the fodder with higher nitrogen levels can be attributed to the improved yields of green fodder, which are influenced by nitrogen availability. Coldwell (1960) also reported a synergistic effect of N and P on phosphorus uptake and yield, supporting the positive relationship between nitrogen levels and nutrient uptake in fodder. The higher removal of N, P, and K with the 180 kg N/ha level can be explained by the enhanced development of roots and shoots resulting from the availability of higher nitrogen, thereby facilitating greater nutrient uptake.

Available nutrients in soil:

The data presented in Table.2 provides information on the levels of available N, P_2O_5, and K_2O in the soil after harvest, as influenced by various nitrogen levels, time of nitrogen application, and their interaction effect. Available N and P_2O_5P2O5 in the soil after harvest were significantly affected by different nitrogen levels. The highest levels of available N and P_2O_5 in the soil after harvest (197.25 and 47.53 kg/ha, respectively) were observed with the application of nitrogen at 180 kg N/ha (N4), which was similar to the levels recorded at 150 kg N/ha (N_3). Conversely, the lowest levels of available N and P_2O_5 (155.65 and 336.99 kg/ha, respectively) were registered with the application of nitrogen at 90 kg N/ha (N_1). However, the available K_2O in the soil after harvest did not show significant differences among the different nutrient management treatments. Furthermore, the timing of nitrogen application had a significant effect on the levels of available N and P_2O_5 in the soil after harvest. The treatment of ¼ basal + ½ at knee height + ¼ tasseling (T_4) resulted in significantly higher levels of available N and P_2O_5 (189.95 and 45.84 kg/ha, respectively) in the soil after harvest. These levels were similar to those observed with the treatments of $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). On the other hand, the lowest levels of available N and P_2O_5 in the soil after harvest (156.37 and 39.49 kg/ha, respectively) were recorded with the treatment of ½ basal + ½ at knee height (T_1). However, the available K_2O in the soil after harvest did not show significant differences among the different timing of nitrogen application treatments. the interaction between nitrogen levels and time of nitrogen application did not influence available nutrients after the harvest of sweet corn.

Conclusion:

Based on above results and discussion, ~~concluded that,importance of nitrogen management~~it can be concluded that nitrogen management is of great importance in sweet corn cultivation to enhance the nutritional quality and productivity of both grain and fodder. The application of 180 kg/ha nitrogen gave best results.When nitrogen was applied in three splits, specifically at ¼ basal + ½ at knee height + ¼ tasseling, it can contribute to achieving desirable protein and sugar content, as well as improving NPK uptake and availability of nitrogen and phosphorus.

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Table 1: Effect of different nitrogen levels and time of nitrogen application on sweet corn grain quality and NPK content

Treatments	Total sugar content (%)	Protein content (%)		N, P and K content (%) in grain			N, P and K content (%) in Fodder		
		Grain	Fodder	N	P	K	N	P	K
(N) Nitrogen levels									
N_1 : 90	10.78	8.65	2.87	1.384	0.240	0.307	0.459	0.185	0.497
N_1: 120	11.78	8.83	3.05	1.413	0.244	0.327	0.487	0.189	0.506
N_1: 150	14.41	9.56	3.65	1.529	0.250	0.334	0.585	0.192	0.526
N_1: 180	14.96	10.51	3.88	1.681	0.254	0.341	0.621	0.196	0.537
S.Em.±	0.23	0.38	0.08	0.061	0.008	0.009	0.013	0.004	0.014
C.D. at 5%	0.65	1.10	0.24	0.176	NS	NS	0.038	NS	NS
(T) Time of nitrogen application									
T_1 : ½ Basal + ½ at knee height	11.95	8.43	3.10	1.384	0.239	0.309	0.497	0.185	0.486
T_2 : ½ Basal + ¼ knee height + ¼ tasseling	13.10	9.43	3.31	1.509	0.247	0.327	0.530	0.190	0.517
T_3 : $^1/_3$ Basal + $^1/_3$ knee height + $^1/_3$ tasseling	13.25	9.80	3.50	1.568	0.248	0.331	0.559	0192	0.522
T_4 : ¼ Basal + ½ at knee height + ¼ tasseling	13.65	9.89	3.54	1.582	0.254	0.342	0.566	0195	0.541
S.Em.±	0.23	0.38	0.08	0.061	0.008	0009	0.013	0.004	0.014
C.D. at 5%	0.65	1.10	0.24	0.176	NS	NS	0.038	NS	NS
N X T	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	6.03	14.07	8.43	14.07	10.67	9.76	8.43	7.84	9.21

Table 2: Effect of different nitrogen levels and time of nitrogen application on NPK uptake and available nutrients in soil

Treatments	N, P, and K uptake (kg/ha) by grain			N, P, and K uptake (kg/ha) by fodder			Available nutrients (kg/ha)		
	N	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
(N) Nitrogen levels									
N_1 : 90	47.50	9.21	30.81	51.88	17.66	80.84	155.65	39.48	336.99
N_1: 120	50.34	10.28	35.27	62.98	18.72	98.48	163.46	41.60	343.50
N_1: 150	56.85	12.68	42.34	87.15	21.13	118.16	186.90	44.13	351.69
N_1: 180	61.49	13.74	45.66	92.15	22.19	124.19	197.25	47.53	361.03
S.Em.±	2.29	0.42	1.62	2.78	0.81	3.76	6.51	1.41	13.33
C.D. at 5%	6.62	1.20	4.67	8.03	2.35	10.86	18.81	4.07	NS
(T) Time of nitrogen application									
T_1 : ½ Basal + ½ at knee height	48.57	9.97	35.14	58.46	17.74	82.68	156.37	39.49	339.34
T_2 : ½ Basal + ¼ knee height + ¼ tasseling	53.26	11.67	37.10	75.38	19.86	109.29	174.60	43.31	345.03
T_3 : $^1/_3$ Basal + $^1/_3$ knee height + $^1/_3$ tasseling	56.36	11.79	40.10	77.81	20.53	112.50	182.34	44.10	351.33
T_4 : ¼ Basal + ½ at knee height + ¼ tasseling	57.99	12.48	41.66	82.86	21.58	117.21	189.95	45.84	357.51
S.Em.±	2.29	0.42	1.62	2.78	0.81	3.76	6.51	1.41	13.33
C.D. at 5%	6.62	1.20	4.67	8.03	2.35	10.86	18.81	4.07	NS
N X T	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	14.69	12.54	14.55	13.09	14.16	12.36	12.83	11.29	13.26