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Effect of Different Rates and Times of Nitrogen Application on Growth, Yield Attributes and Yield of Sweet Corn (*Zea mays* L. *saccharata*) Under South Gujarat Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during the *rabi* season in 2017-18 to study the effect of different rates and times of nitrogen application on growth, yield attributes and yield of sweet corn (*Zea mays* L. *saccharata*) under south Gujarat conditions. The experiment was laid out in a Factorial randomized block design (FRBD) with three replications. The factors consisted of four nitrogen levels *i.e.,* 90 kg ha^{-1} (N_1), 120 kg ha^{-1} (N_2), 150 kg ha^{-1} (N_3) and 180 kg ha^{-1} (N_4) and four treatments of split application *i.e.,* 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), ¼ basal + ½ at knee height + ¼

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tasseling (T_4). The results revealed that increasing the nitrogen level from 90 (N_1) to 180 (N_4) kg ha^{-1} significantly increased the growth attributes *viz,* plant height, stem diameter, number of leaves, yield attributes *viz,* number of grains per cob, weight of grains per cob, weight of cob per plant, green cob and fodder yield. Significantly higher green cob (132.94 q ha^{-1}) and fodder yield (307.29 q ha^{-1}) with net return (Rs.258239 ha^{-1}) and benefit: cost ratio of 4.74 was obtained with 180 kg ha^{-1} nitrogen application. Application of nitrogen in three splits *i.e.,* at ¼ basal + ½ at knee height + ¼ tasseling (T_4) recorded significantly higher growth characters *viz,* plant height, stem diameter, number of leaves, yield attributes *viz*, number of grains per cob, weight of grains per cob, weight of cob per plant, green cob (126.99 q ha^{-1}) and fodder yield (293.14 q ha^{-1}) with net return (Rs.242739 ha^{-1}) and benefit: cost ratio of 4.47.

Keywords: Nitrogen; time of application; sweet corn; knee height; fodder yield.

1. INTRODUCTION

Maize (*Zea mays* L.) is also known as Indian corn while in the United States of America, it is simply known as corn. It is one of the most important cereal crops in the world's agricultural economy and is used both as food for humans and feed for animals. Globally, maize is known as the "Queen of Cereals" because it has the highest genetic yield potential among cereals. Being a C_4 plant, it is capable to utilize solar radiation more efficiently even at higher radiation intensity. "It is one of the most versatile crops having wider adaptability under varied agro-climatic conditions. It is cultivated on an area of 150 million ha with a production of 782 million tonnes of grain and productivity of 4.92 t ha^{-1}. In India, it is cultivated on an area of 6.4 million ha with a production of 20.3 million tonnes of grain and productivity of 2.43 t ha^{-1}. Haryana, Maharashtra, Meghalaya, Karnataka, and Andhra Pradesh are the major sweet corn-producing state of India. While Gujarat occupies an area of 4.7 lakh ha producing 12.2 lakh tonnes of grain with a productivity of 2.59 t ha^{-1}. Maize contributes 36 % (782 mt) in the global grain production" [1].

Sweet corn is becoming popular and is being cultivated in maize-growing areas of India. Being a high-value crop, there is a growing demand for sweet corn in star hotels for soup making. In addition, the seed of this crop is used for canning purposes and the preparation of different sweet items. The added advantage of sweet corn is that after the harvest of green ears, the crop remains at the green stage and it is fit for feeding cattle as green fodder. Due to its short duration, it is finding a place in different cropping systems. It has been tried in different low canopy crops like groundnut, green gram, black gram and high canopy crops like a red gram of varying durations as intercrop and found most suitable. As far as Gujarat is concerned, there is an adequate possibility that the production of sweet corn in South Gujarat can be taken as a substitute for paddy because of the availability of irrigation water and sweet corn is a short-duration crop; it is best suited in existing cropping systems after *kharif* rice. The lack of knowledge about the use and economic importance of sweet corn and the unavailability of appropriate production technologies are the major constraints to its popularization among Indian maize growers. It is a fact that plant growth and higher grain yield depend on adequate fertilizer application at the right time in particular, nitrogen. The inadequate management of nitrogen (N) is considered a major limiting factor for maize grain yield. Results obtained by Lemaire and Gastal [2] demonstrated that, under appropriate levels of other nutrients in the soil, nitrogen provides the greatest increment to maize yield. Nitrogen is subjected to several transformations in the soil; thus, it is considered a dynamic and complex element, generating debates and controversies regarding its best source and time of application in crops especially in maize.

Therefore, it is essential to know the optimum level of nitrogen and timing of application for getting a higher crop yield so that maximum benefits could be realized. Inadequate nitrogen availability during the first six weeks after planting can result in decreased source, sink, size and reduced yield potentials. Nitrogen use and demand are continuously increasing day by day. Since nitrogen is highly mobile, it is subjected to greater loss from the soil plant system. Therefore, matching the optimum level of nitrogen and timing of nitrogenous fertilizer application is essential to achieve the targeted yields. However, no systematic research has been conducted to develop site and situation-specific production technology for sweet corn. Hence, there is a need to establish a relationship between nitrogen levels and the timing of nitrogen application.

2. MATERIALS AND METHODS

The experiment was conducted at College Farm, N. M. College of Agriculture, NAU, Navsari during the *rabi* season of 2017-18. The place is located 12 km away in the east from the great historical place "Dandi" on the Arabian seashore. The climate of this region is characterized by a fairly hot summer, moderately cold winter and warm humid monsoon with heavy rainfall. The soil of the experimental site is dark greyish brown type with flat topography. The soil is characterized by medium to poor drainage and good water-holding capacity. Data from initial soil analysis indicated that the experimental site was clay in texture and showed low, high and high ratings for available nitrogen (209.6 kg ha^{-1}), phosphorus (40.62 kg ha^{-1}) and potassium (384.32 kg ha^{-1}), respectively. The soil was found slightly alkaline (pH 7.9) with normal electric conductivity (0.37 ds m^{-1}). The present experiment was laid out in Factorial Randomized Block Design with 16treatments combinations of four nitrogen levels *i.e.,* 90 kg ha^{-1} (N_1), 120 kg ha^{-1} (N_2), 150 kg ha^{-1} (N_3) and 180 kg ha^{-1} (N_4) and four treatments of split application *i.e.,* 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), ¼ basal + ½ at knee height + ¼ tasseling (T_4) with three replications. The entire quantity of phosphorus and potash applied as basal through SSP and MOP fertilizer respectively, whereas nitrogen applied in form of urea as per treatments. Recorded observations on growth, yield parameters and yield were taken as per the standard method. The data was analyzed using standard statistical techniques [3]. The present experiment was to study the effect of different rates and times of nitrogen application on growth, yield attributes and yield of sweet corn (*Zea mays* L. *saccharata*) under south Gujarat conditions.

3. RESULTS AND DISCUSSION

3.1 Effect on Growth Attributes

3.1.1 Plant height (cm)

The data pertaining to plant height was recorded at periodical intervals 30 DAS, 60 DAS and at the harvest of sweet corn as influenced by nitrogen levels and time of nitrogen application in Table 1. A perusal of data indicated that different nitrogen levels had a significant effect on plant height recorded at 60 DAS and at harvest of sweet corn except at 30 DAS. Significantly the tallest plants (115.78 and 207.99 cm, respectively 60 DAS and at harvest) were observed under the nitrogen rate 180 kg N ha^{-1} (N_4) and it was at par with 150 kg N ha^{-1} (N_3). Whereas the shortest plant (100.18 and 183.17 cm, respectively) was recorded in nitrogen rate 90 kg N ha^{-1} (N_1) at 60 DAS and at harvest. Time of nitrogen application had a profound influence on plant height at the growth stages *i.e.,* at 60 DAS and at harvest of sweet corn except at 30 DAS. Application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) recorded the significantly highest plant height (112.08 and 208.52 cm respectively) at 60 DAS and at harvest and it was at par with $^1/_3$ Basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). Significantly the lowest plant height (98.95 and 180.19 cm, respectively) was observed with the application of nitrogen at ½ basal + ½ at knee height (T_1) treatment during growth stages *i.e.,* at 60 DAS and at harvest of sweet corn. The maximum plant height recorded at higher levels of nitrogen might be due to more cell division and cell elongation as promoted by nitrogen. Adequate nitrogen supply increased the amount of cell plasma and chlorophyll, which is a factor for the growth of the crops. Milthrope and Moorby [4] observed that under adequate nitrogen supply, cells elongate extensively along the main axis leading to more growth of internodes and increasing the length of the stem. The increase in plant height in response to higher levels of nitrogen conformed with the findings of Kumar [5], Bhatt [6] and Singh et al. [7].

3.1.2 Number of leaves per plant

It was observed from data presented in Table 1, that 180 kg N ha^{-1} (N_4) was recorded significantly as the maximum number of leaves per plant (10.96 and 15.60, respectively) and it was at par with 150 kg N ha^{-1} (N_3). Whereas, the minimum number of leaves per plant (9.82 and 13.82) was recorded with 90 kg N ha^{-1} (N_1) at 60 DAS and harvest, respectively. In the case of time of nitrogen application, significantly the maximum number of leaves per plant (10.98 and 15.42, respectively) was recorded with ¼ basal + ½ at knee height + ¼ tasseling (T_4) and it was at par with $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_1). Whereas, the minimum number of leaves per plant (9.46 and 13.84, respectively) was recorded with ½ Basal + ½ at knee height (T_1) at 60 DAS and at harvest. These findings are in contrast with the results of Bhatt [6] and Singh et al. [7].

3.1.3 Plant stem diameter (cm)

Perusal of data shown in Table 1 reflected that significant differences were noticed due to different nitrogen levels and time of nitrogen application at 60 DAS and at harvest except at 30 DAS. Significantly the maximum stem diameter (1.40 cm and 1.94 cm, respectively) was recorded with 180 kg N ha^{-1} (N_4) and it was at par with 150 kg N ha^{-1} (N_3). While, the significantly lowest stem diameter (1.29 cm and 1.76 cm) was recorded with 90 kg ha^{-1} (N_1) at 60 DAS and at harvest respectively. Application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) was recorded significantly the maximum stem diameter (1.38 and 1.93 cm, respectively) and it was at par with $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). Whereas, significant minimum stem diameter (1.29 cm and 1.75 cm) was recorded with the application of nitrogen at ½ basal + ½ at knee height (T_1) at 60 DAS and at harvest, respectively. Similar results were confirmed by Kumar [5] and Singh et al. [7].

3.1.4 Days to 50% tasseling

The experiment result presented in Table 1, indicated that the response of days to 50 % tasseling due to different nitrogen levels and time of nitrogen application was found to be significant. Among different rates of nitrogen, day to 50 % tasseling was observed late (55.24 days) in nitrogen rate 180 kg N ha^{-1} (N_4) and A minimum days of 50 % tasseling (51.99 days) was recorded with the application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4). These results are in full agreement with the findings of Thakur et al. [8].

3.2 Yield Attributes

The number of cobs per plant, cob length per plant with and without husk, cob diameter per plant with and without husk, cob weight per plant, number of grains per row of cob, number of grain row per cob, number of grains per cob, fresh weight of grain per cob of sweet corn were influenced by nitrogen rates which presented in Table 2.

3.2.1 Number of cobs per plant

Data on the number of cobs per plant was recorded at the harvest of sweet corn as influenced by various nitrogen levels and time of nitrogen application in Table 2. Analysis of data indicated that the number of cobs per plant at harvest was found to be not significant under different nitrogen levels and different times of nitrogen application.

3.2.2 Cob length

Data concerning cob length as influenced by various nitrogen levels and time of nitrogen application are in Table 2. The highest cob length with and without husk (23.78 cm and 17.38 cm, respectively) was obtained in 180 kg N ha^{-1} (N_4). Whereas, the significantly lowest cob length with and without husk (20.67 cm and 15.27 cm, respectively) was found in 90 kg N ha^{-1} (N_1). Such an effect of greater cob length due to 180 kg N ha^{-1} could be attributed to its favourable effect on cell enlargement in the production of larger leaves and improving the photosynthetic efficiency of plants. These results are in tune with the findings reported by Bhatt [6], Singh et al. [7], Arvadiya et al. [9] and Sunitha and Reddy [10]. A perusal of the data showed that cob length was significantly affected by the time of nitrogen application. Application nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) was recorded significantly the maximum cob length with and without husk (23.27 cm and 16.95 cm, respectively) and it was at par with $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2).

3.2.3 Cob diameter

It was observed from data presented in Table 2, that Influence of nitrogen levels and time nitrogen application was found significant on cob diameter with and without husk. Significantly highest cob diameter with and without husk (5.98 cm and 5.06 cm, respectively) was recorded with nitrogen level 180 kg N ha^{-1} (N_4) and it was at par with 150 kg N ha^{-1} (N_4). Whereas, the lowest cob diameter with and without husk (5.41 cm and 4.69 cm, respectively) was found in 90 kg N ha^{-1} (N_1). The data revealed that the higher cob diameter with and without husk (5.85 cm and 4.98 cm, respectively) were found with the application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) and it was at par with

Table 1. Effect of different nitrogen level and time of nitrogen application on growth parameters of sweet corn

Treatments	Plant height			Leaves plant^{-1} (no.)			Stem diameter (cm)			Days to 50% tasseling
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	
(N) Nitrogen levels										
N_1 : 90	37.73	100.18	183.17	5.52	9.82	13.82	0.99	1.29	1.76	51.41
N_1: 120	37.88	102.17	193.43	5.48	10.02	14.48	1.01	1.32	1.83	52.74
N_1: 150	38.60	108.65	204.41	5.80	10.52	15.14	1.03	1.37	1.92	53.91
N_1: 180	39.42	115.78	207.99	5.84	10.96	15.60	1.05	1.40	1.94	55.24
S.Em.±	0.68	2.50	3.57	0.16	0.29	0.35	0.02	0.02	0.02	0.75
C.D. at 5%	NS	7.23	10.31	NS	0.83	1.00	NS	0.07	0.07	2.16
(T) Time of nitrogen application										
T_1 : ½ Basal + ½ at knee height	37.55	98.95	180.19	5.48	9.46	13.84	1.00	1.29	1.75	55.49
T_2 : ½ Basal + ¼ knee height + ¼ tasseling	37.72	105.72	199.23	5.50	10.34	14.70	1.00	1.34	1.88	53.07
T_3 : $^1/_3$ Basal + $^1/_3$ knee height + $^1/_3$ tasseling	39.08	110.03	201.06	5.76	10.56	15.08	1.02	1.36	1.89	52.74
T_4 : ¼ Basal + ½ at knee height + ¼ tasseling	39.28	112.08	208.52	5.90	10.98	15.40	1.06	1.38	1.93	51.99
S.Em.±	0.68	2.50	3.57	0.16	0.29	0.35	0.02	0.02	0.02	0.75
C.D. at 5%	NS	7.23	10.31	NS	0.83	1.00	NS	0.07	0.07	2.16
INTERACTION										
N X T	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	6.12	8.12	6.27	9.95	9.68	8.13	6.62	5.98	4.25	4.86

treatments $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). Whereas, the lowest cob diameter with and without husk (5.54 cm and 4.66 cm, respectively) were found with the application of nitrogen at ½ Basal + ½ at knee height (T_1). These results are in partial conformity with those reported by Sunitha and Reddy [10].

3.2.4 Cob weight per plant

Data presented in Table 2, showed that cob weight per plant was influenced significantly by various nitrogen levels. Significantly highest cob weight per plant with and without husk (252.17 g and 210.17 g, respectively) was recorded with 180 kg N ha^{-1} (N_4) and it was at par with 150 kg N ha^{-1} (N_3). Whereas, the lowest cob weight per plant with and without husk (172.42 g and 137.42 g, respectively) was found in 90 kg N ha^{-1}. During the time of nitrogen application treatments, application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) was found to significantly highest cob weight with and without husk per plant (227.11 and 196.08 g, respectively) and it was at par with treatments $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). Whereas, the lowest cob weight with and without husk per plant (196.92 g and 150.75 g, respectively) were found with the application of nitrogen at ½ basal + ½ at knee height (T_1). These findings are in contrast with the result of Bhatt [6] and Singh et al. [7].

3.2.5 Number of grains per row of cob

The result of data presented in Table 2, grains per row of cob revealed that Among the nitrogen levels tested, 180 kg N ha^{-1} (N_4) was found significantly highest number of grains per row of cob (34.02) and it was at par with nitrogen level 150 kg N ha^{-1} (N_3). Whereas, the lowest number of grains per row of cob (27.19) found in nitrogen level 90 kg N ha^{-1} (N_1). Among the different time of nitrogen application, significantly higher numbers of grains per row of cob (32.46) were found in the application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) and it was at par with treatments $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). Whereas, the lowest numbers of grains per row of cob (28.78) were found with the application of nitrogen at ½ basal + ½ at knee height (T1). These results are in partial conformity with those reported by Kumar [5] and Bhatt [6].

3.2.6 Number of grains row per cob

It was evident from the data presented in Table 2, that the significantly highest number of grains per row of cob (34.02) was recorded with 180 kg N ha^{-1} (N_4) and it was at par with nitrogen level 150 kg N ha^{-1}. Whereas, the lowest number of grain rows per cob (13.26) was found in nitrogen level 90 kg N ha^{-1} (N_1). Among the treatments time of nitrogen application, significantly higher numbers of grain row per cob (14.38) were found with application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) and it was at par with treatments 1/3 basal + $^1/_3$ knee height + $^1/_3$ tasseling and ½ basal + ¼ knee height + ¼ tasseling (T_2). Whereas, the lowest number of grain rows per cob (12.32) were found with application of nitrogen at ½ basal + ½ at knee height (T_1). Similar results were confirmed by Kumar [5] and Bhatt [6].

3.2.7 Number of grains per cob

Data furnished in Table 2, indicated that the number of grains per cob was influenced significantly by nitrogen levels and time of nitrogen application. In the case of nitrogen levels, 180 kg N ha^{-1} (N_4) was found to significantly the highest number of grains per cob (454.03) and was at par with nitrogen level 150 kg N ha^{-1} (N_3). Whereas, the lowest number of grains per cob (335.57) found in nitrogen level 90 kg N ha^{-1} (N_1). Among the time of nitrogen application, significantly higher numbers of grains per cob (409.77) were found in application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) and it was at par with treatments $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). Whereas, the lowest numbers of grains per cob (340.22) were found with application of nitrogen at ½ basal + ½ at knee height (T_1). These results are collaborated to Sahoo and Mahapatra [11] and Bhatt [6].

3.2.8 Fresh weight of grains per cob

Data presented in Table 2, show that fresh weight of grain per cob was influenced significantly by various nitrogen levels and time of nitrogen application. In the case of nitrogen levels, the significantly highest fresh weight of grain per cob (189.95 g) was recorded with nitrogen level 180 kg N ha^{-1} (N_4). Whereas, the lowest fresh weight of grain per cob (154.28 g) found in 90 kg N ha^{-1} (N_1). In the treatments time of nitrogen application, the significantly highest fresh weight of grain per cob (183.56 g) was found with application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) and it was at par with treatments $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). Whereas, the lowest fresh weight of grain per cob (155.69 g) was found with application of nitrogen at ½ basal + ½ at knee height (T1). Statistically significant values recorded for fresh kernel weight with the application of 180 kg N ha^{-1} were probably due to availability of adequate and balanced nutrients in the higher nitrogen level, which resulted in heavier and bolder kernels compared to those at lower nitrogen levels. Similar results were also reported by Sahoo and Mahapatra [11], Kumar [5], Narayanaswamy and Siddaraju [12] and Bhatt [6].

3.3 Yield

Data pertained to green cob yield, green fodder yield and harvest index was presented in Table 2.

3.3.1 Green cob yield

The mean data on green cob yield of sweet corn as influenced by various nitrogen levels and time of nitrogen application have been presented in Table 2. The data revealed that a significantly higher green cob yield (132.94 q ha^{-1}) was recorded in nitrogen level 180 kg N ha^{-1} (N_4) and it was at par with nitrogen level 150 kg N ha^{-1} (N_3). Whereas significantly higher green cob yield (126.99 q ha^{-1}) was recorded with the application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) and it was at par with $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). The positive response to a higher level of nitrogen on green cob yield could be ascribed to an overall improvement in crop growth that enabled the plant to absorb more nutrients, moisture, higher light interception, and increased leaf area which might have enabled the plant to accumulate more quantities of photosynthates in the sink. Similar findings of the response of sweet corn to higher nitrogen levels were reported by Kumar [5], Akintoye and Kintomo [13], Narayanaswamy and Siddaraju [12], Bhatt [6] and Singh et al. [7].

Table 2. Effect of different nitrogen levels and time of nitrogen application on yield attributes and yield of sweet corn

Treatments	Cobs plant^{-1} (no.)	Cob length (cm)		Cob diameter (cm)		Cob weight plant^{-1} (g)		Grain row cob^{-1} (no.)	No. of grain row^{-1}	Grains cob^{-1} (no.)	Fresh weight of grain cob^{-1} (g)	Green cob yield (q ha^{-1})	Green Fodder yield (q ha^{-1})	Harvest index (%)	B:C
		With husk	Without husk	With husk	Without husk	With husk	Without husk								
(N) Nitrogen levels															
N_1 : 90	1.38	20.67	15.27	5.41	4.69	172.42	137.42	13.26	27.19	335.57	154.28	94.68	241.55	28.08	3.39
N_1: 120	1.25	21.86	15.42	5.66	4.71	194.08	173.08	13.50	28.16	355.97	163.60	105.36	256.98	28.93	3.72
N_1: 150	1.28	23.00	16.53	5.79	4.93	238.27	199.00	13.78	32.77	423.25	182.36	123.00	289.82	29.74	4.29
N_1: 180	1.37	23.78	17.38	5.98	5.06	252.17	210.17	14.14	34.02	454.03	189.95	132.94	307.29	30.02	4.59
S.Em.±	0.05	0.60	0.42	0.07	0.08	7.22	5.62	0.21	0.80	12.12	3.76	4.48	6.85	0.99	-
C.D. at 5%	NS	1.72	1.23	0.21	0.23	20.86	16.23	0.62	2.30	35.00	10.87	12.94	19.79	NS	-
(T) Time of nitrogen application															
T_1 : ½ Basal + ½ at knee height	1.28	20.66	15.28	5.54	4.66	196.92	150.75	12.32	28.78	340.22	155.69	91.07	249.09	26.80	3.27
T_2 : ½ Basal + ¼ knee height + ¼ tasseling	1.32	22.51	15.88	5.70	4.86	212.92	183.58	13.92	30.34	399.98	173.19	117.17	274.37	29.78	4.01
T_3 : $^1/_3$ Basal + $^1/_3$ knee height + $^1/_3$ tasseling	1.38	22.87	16.50	5.75	4.89	220.00	189.25	14.05	30.56	418.84	177.74	120.75	279.05	30.06	4.12
T_4 : ¼ Basal + ½ at knee height + ¼ tasseling	1.30	23.27	16.95	5.85	4.98	227.11	196.08	14.38	32.46	409.77	183.56	126.99	293.14	30.14	4.34
S.Em.±	0.05	0.60	0.42	0.07	0.08	7.22	5.62	0.21	0.80	12.12	3.76	4.48	6.85	0.99	-
C.D. at 5%	NS	1.72	1.23	0.21	0.23	20.86	16.23	0.62	2.30	35.00	10.87	12.94	19.79	NS	-
INTERACTION															
N X T	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-
C.V. %	13.17	9.25	9.10	4.49	5.59	11.68	10.82	5.41	9.04	10.70	7.55	13.62	8.66	11.78	-

3.3.2 Green fodder yield

It was observed from data presented in Table 2, that green fodder yield (307.29 q ha^{-1}) of sweet corn was significantly highest with nitrogen level 180 kg N ha^{-1} (N_4) and it was at par with nitrogen levels 150 kg N ha^{-1} (N_3). Among the different times of application, significantly higher green fodder yield (293.14 q ha^{-1}) was recorded with the application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4) and it was at par with treatments $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) and ½ basal + ¼ knee height + ¼ tasseling (T_2). Positive response of high nitrogen application at the right time on growth parameters like plant height, stem diameter and number of plant leaves directly affect on green fodder yield. These results are in full agreement with the findings of Akbar et al. [14], Kar et al. [15], Kumar [5], Bhatt [6] and Singh et al. [7].

3.3.3 Harvest index

The statistical analysis of the data presented in Table 2 revealed that the difference in harvest index at harvest was found non-significant due to various nitrogen levels and time of nitrogen levels.

3.4 Effect on Economics

A perusal of data shown in Table 2 reflected that a maximum B:C ratio of 4.59 was accrued with nitrogen level 180 kg N ha^{-1} (N_4), and in case of time of nitrogen application, at ¼ basal + ½ at knee height + ¼ tasseling (T_4) was recorded maximum B:C ratio of 4.34, which was followed by application of nitrogen at $^1/_3$ basal + $^1/_3$ knee height + $^1/_3$ tasseling (T_3) with B:C ratio 4.12. This was attributed to higher cob and fodder yield also chemical fertilizers are cheaper and required less quantity to supply a recommended dose of nutrients hence the cost of cultivation was lower with the application of nitrogen at ¼ basal + ½ at knee height + ¼ tasseling (T_4), ultimately reflected into the higher net return and BCR. These results are in partial conformity with those reported by Kumar [5].

3.5 Interaction Effect on Growth, Yield Attributes and Yield of Sweet Corn

An examination of data presented in Table 1 and Table 2 interaction effect of different rates of nitrogen and time of nitrogen application treatments revealed that the interaction effect of various nitrogen rates and different times of nitrogen application treatments on growth parameters, yield attributes and yield of sweet corn was found not significant.

4. CONCLUSION

Given the results obtained from the one-year investigation, it is concluded that the higher green cob and fodder yield with higher net returns can be obtained with the application of 180 kg ha^{-1} (N_4) nitrogen and in three splits at a time of ¼ basal + ½ at knee height + ¼ tasseling (T_4).

CONFERENCE DISCLAIMER

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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