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EFFECT OF NITROGEN LEVELS AND APPLICATION SCHEDULING ON THE GROWTH AND YIELD OF MAIZE

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Abstract

A field trial was conducted to assess the effect of Nitrogen (N) levels and application scheduling on the growth and grain yield of maize. The results revealed that growth and grain yield traits of maize were influenced significantly (P<0.01) due to different Nitrogen (N) levels and application schedule. Crop fertilized with the highest Nitrogen (N) level of 180 kg per ha resulted from 185.07 cm plant height, 11.94 leaves per plant, 473.92 cm leaf area per plant, 1.73 cobs per plant, 347.91 grains per cob, 15650.33 kg biomass yield and 3030.28 kg grain yield per ha. The crop receiving Nitrogen (N) at the rate of 120 kg per ha gave 177.67 cm plant height, 10.91 leaves per plant, 464.44 cm leaf area per plant, 1.60 cobs per plant, 237.04 grains per cob, 14241.80 kg biomass yield and 2762.30 kg grain yield per ha; while lowest Nitrogen (N) rate of 60 kg per ha resulted from 170.26 cm plant height, 9.89 leaves per plant, 455.15 cm leaf area per plant, 1.47 cobs per plant, 307.41 grains per cob, 13672.13 kg biomass yield and 2541.32 kg grain yield per ha. The effect of the scheduling of Nitrogen (N) application suggested that Nitrogen (N) applied in four equal splits, 25% each, 14, 28 and 42 days after emergence (DAE) ranked 1st.

Keywords: Growth, Nitrogen Levels, Scheduling, Yield of Maize

INTRODUCTION

Maize (Zea mays) is one of the key and common cereal crops due to its high value as a nutritious food and its demand for animal feed and fuel as well as for construction (Dowswell, 2019). Maize is also the most important stable crop in Asian rural families regarding calorie intake. Because of its multiple advantages, it ranks second in the production area next to teff while ranking first among major cereal crops in its productivity and is therefore one of the highest priority crops for feeding the ever-increasing world population (Zhang *et al*., 2020). Although its current productivity is higher than other major cereal crops, yield productivity is below potential. For example, the potential yields in research areas of up to 10–12-ton ha^{-1} and 7–9 ton ha^{-1} in farming can be achieved in the late-ripening hybrid maize varieties, whereas the average productivity is 3,2 ton ha^{-1}. While many biotic and abiotic factors may lead to these huge yield gaps, soil fertility degradation and poor nutrient management are major factors in low productivity (Mourice *et al*., 2015). One of the key concerns is the management of nitrogen (N) in the maize production system because it is the most essential and primary nutrient for crop growth and development (Zhang *et al.*, 2015). Therefore, the application of fertilizer N which results in higher biomass is often increased. The optimum N application rate and time will improve productivity yields and efficiencies in nutrient usage while reducing environmental emissions (Qu *et al*., 2020; Shi *et al*., 2020). Under the optimal maize requirement method, the production cannot be increased, leading to an elevated level of NO3 in the soil and to NO3 loss susceptibility by leaching (Xu *et al*., 2020). Another study also indicated that abundant N supply favors losses from NH3, especially if the supply exceeds plant requirements (Jatana *et al*., 2020). However, efficient management of N may minimize the adverse effects on the environment associated with maize production, including appropriate N recommendation time and rates (Ransom *et al*., 2020). Time of application of N at the correct stage of crop growth is also another key focus for enhancing efficiency of use of N and the productivity of maize. The crop does not absorb all applied N because leaching is one of the major challenges for N loss in high rainfall areas. Research studies have shown that at higher doses of applied N, about 50 percent and even more than this figure remain inaccessible to a crop due to N loss from leaching (Dybowski *et al*., 2020). This leaching loss can be determined by a quantity of N applied, inadequate application period, soil permeability, and amount of falling rainfall in the region (Cogger *et al*., 2020). An optimal and effective application time, however, will increase the recovery of applied N up to 58–70 per cent and thus increase the crop's yield and grain quality (de Oliveira Silva *et al*., 2020). The present experiment was conducted to investigate the effect of nitrogen levels and application scheduling on the growth and yield of

MATERIALS AND METHODS

To examine the effect of various nitrogen levels and scheduling of N application on maize. The experiment was conducted into three replications in the split-plot design. Experimental treatments are given as bellow.

Main plot (N rates) = 3
N1 = 60 kg N ha^{1}
N2 = 120 kg N ha^{1}
N3 = 180 kg N ha^{1}
Sub-plot (Application scheduling) = 6
S1 = 50% at sowing and 50% at 14 DAE (days after emergence)
S2 = 50% at sowing, 25% at 14 DAE and 25% at 28 DAE (three unequal splits)
S3 = 33.3% each at sowing, 14 DAE and at 28 DAE (three equal splits)
S4 = 25% each at sowing, 14, 28, and 42 DAE (four equal splits)
S5 = 20% each at sowing, 14, 28, 42 and 56 DAE (five equal splits)
S6 = 8.3, 16.6, 25, 33.3 and 16.6% at sowing, 14, 28, 42, and 56 DAE, respectively
(Five unequal splits)

The land is subjected to precise land leveling after two dry tillages. After soaking when the soil is in good condition, the cultivator is used for two tillages, and then the planking is carried out to achieve a good seedbed. 60 kg per ha P2O5 and 50 kg per ha K2O were used at constant doses in all experimental treatments. Nitrogen, phosphorus, and potassium are applied in the form of urea, single superphosphate (SSP) and potassium sulfate (SOP), and the crops are irrigated on schedule. Corn is sown by a single Colter. At the time of sowing, all of P and K were applied by mixing in the soil in which the seedbed was prepared, and N was divided into different portions and applied following the schedule of the treatment plan. All other cultural practices were uniformly performed on all plots and the observations for the following parameters were recorded based on five randomly selected plants in each plot. Data were statistically analyzed according to Glaz and Yeater (2020) and means will be compared between treatments by the least significant difference (LSD) test at $P \leq 0.05$.

RESULTS

The maize plants were observed for various agronomical characters such as plant height (cm), number of leaves per plant, leaf area per plant (cm), number of cobs per plant, number of grains per cob, biomass yield per ha (kg) and grain yield per ha (kg). The results on these traits of maize are recorded in Tables-1 to 7.

Plant height (cm): Plant height is the main growth trait of plants such as corn, which is affected by the genetic makeup of the cultivar or related to the fertility status of the soil. Table 1 lists the results associated with maize plant height affected by nitrogen (N) levels and their application schedules. Nitrogen application rate, nitrogen application schedule and mutagenesis significantly affected plant height (P<0.01). The maximum height (185.07 cm) was recorded in the plots receiving 180 kg N per ha, and the plant height was reduced to 177.67 cm when the nitrogen content was reduced to 120 kg per ha. However, the lowest nitrogen application rate of 60 kg per ha resulted in a minimum plant height of 170.26 cm. In the case of nitrogen fertilizer application, on days 14, 28 and 42 of post-emergence (DAE), on the 14th day, 28th day and 42nd day after sowing, the maize was harvested in four equal divisions (ie, separately at the time of sowing). 25% nitrogen) accepts nitrogen fertilizer; the maximum plant height is 183.04 cm. When the plants receive nitrogen in five equal divisions, i.e. when planting the 14th, 28th, 42th, and 56th DAE, each nitrogen content is For 20%, it is significantly reduced to 182.27 cm. Corn was applied to five maize crops that were not fertilized in stages, ie, 8.3, 16.67, 25.0, 33.33, and 16.6% DAE, 14, 18, 42 and 56 DAE, respectively. 50% and 14 DAE; nitrogen application rate was 50%, sowing nitrogen application rate was 25% and 25%, 14 and 28 DAE were ranked fourth and fifth, and average plant height was 175.29 and 174.58 cm, in descending order. However, the maize crop obtained a minimum plant height of 173.84 cm at three equal divisional stages (i.e., 33.33% nitrogen, respectively, when seeding 14 and 28 days, respectively). Interaction studies showed that the highest plant height was observed at 190.66 cm under N3 x S4 interaction, while the minimum plant height (166.60 cm) was observed under N1 x S3 interaction. It was further observed that there was no significant difference in plant height between S4 and S5 (P > 0.05), and there was no statistically significant difference in plant height between S1, S2, S3, and S6. However, there was a linear effect in increasing nitrogen levels, and the difference between all nitrogen contents was significant for plant height (P<0.01).

Table-1. Plant height (cm) of maize as affected by the rate and schedule

Scheduling of N application	**Nitrogen Rates**			**Av. for N rates**
	N_1=60 kg per ha	**N_2=120 kg per ha**	**N_2=180 kg per ha**	
S1=50%@sowing 50% 14 DAE	167.99	175.30	182.60	175.29 b
S2=50%@sowing, 25, 25% 14, 28 DAE	167.60	174.52	181.80	174.58 b
S3=33.33% each @ sowing, 14 and 28 DAE	166.60	173.84	181.09	173.84 b
S4=25% each @ sowing, 14, 28 and 42 DAE	175.41	183.04	190.66	183.04 a
S5=20% each @ sowing, 14, 28, 42 and 56 DAE	174.67	182.27	189.86	182.27 a
S6=8.3, 16.6, 25, 33.33 and 16.6% @ sowing, 14, 28, 42 and 56 DAE	169.66	177.04	184.41	177.04 b
Average for scheduling of N application	170.26 c	177.67 b	185.07 a	-

	N rates (N)	**Scheduling of N application (S)**	**N x S**
S.E.±	1.2566	1.777	1.0942
LSD 0.05	5.494	6.005	9.730
LSD 0.01	7.527	8.530	12.96

Number of leaves per plant: The number of leaves per plant is a major cause of maize leaf development and is significantly affected by the application of nutrients, particularly nitrogen (N). Table 2 shows the number of plants and their application schedules for maize leaves affected by N levels. Analysis of variance showed that nitrogen levels, nitrogen application schedule, and nitrogen interaction x application schedule had a significant effect on the number of leaf plants 1 (P<0.01).

In the application of 180 kg per ha N (N3) corn, the most noted was the No. 1 plant (11.94) leaves, and as the N content decreased to 120 kg per ha, the number of leaves decreased to 10.91 plants^{-1} (N2). However, with the minimum nitrogen fertilizer of 60 kg per ha (N1), the least leaf (9.89) per plant was observed. In the case of nitrogen fertilizer application, the maize crop received nitrogen fertilizer at four equal divisional stages (S4), i.e. 25% of nitrogen was harvested at 14, 28 and 42 days after emergence (DAE), resulting in the highest number of plant leaves. (12.85) - As shown in Fig. 1, when N is applied in 5 equal parts (S5), that is, when 20% of N is applied at 14, 28, 42 and 56 DAE at the time of sowing, the number of leaves is reduced to 11.93. Per plant. The crops obtained N at the time of five divisions (S6), ie, 8.3, 16.67, 25.0, 33.33 and 16.6% N, 14, 18, 42 and 56 DAE were obtained at the time of sowing, and split in 3 and so on (N was obtained in S3), that is, 33.33% were obtained at the time of sowing, and 14 and 28 DAEs and N were respectively planted in the two divided regions (S1), accounting for 50% and 14 DAEs, respectively yielding an average of 10.85, 10.66 and Average plant of 9.64. The maize crop received N distribution in three divisions, 50% at the time of sowing, and 25% for 14 and 28 DAE (S2), respectively, resulting in the lowest number of leaves per plant (9.56). It was noted from the interaction study that the interaction of N3 x S4 resulted in the largest number of leaves (14.01) per plant, while under the interaction of N1 x S3, the smallest number of leaves (8.68) per plant was noted. Statistically, the number of leaf plants 1 between S4-S5, S3-S6, or S1-S2 was not significantly different (P > 0.05). Nitrogen levels had a direct effect on the number of leaf plants 1 and the difference in all nitrogen content of the traits was significant (P<0.01).

Table-2 Number of leaves per plant of maize as affected by the rate and schedule

Scheduling of N application	**Nitrogen Rates**			**Av. for N rates**
	N_1=60 kg per ha	**N_2=120 kg per ha**	**N_2=180 kg per ha**	
S1=50%@sowing 50% 14 DAE	8.74	9.61	10.56	9.64 c
S2=50%@sowing, 25, 25% 14, 28 DAE	8.68	9.53	10.48	9.56 c
S3=33.33% each @ sowing, 14 and 28 DAE	9.67	10.63	11.68	10.66 b
S4=25% each @ sowing, 14, 28 and 42 DAE	11.60	12.95	14.01	12.85 a
S5=20% each @ sowing, 14, 28, 42 and 56 DAE	10.82	11.89	13.07	11.93 a
S6=8.3, 16.6, 25, 33.33 and 16.6% @ sowing, 14, 28, 42 and 56 DAE	9.85	10.82	11.89	10.85 b
Average for scheduling of N application	9.89 c	10.91 b	11.94 a	-

	N rates (N)	**Scheduling of N application (S)**	**N x S**
S.E.±	0.1325	0.1874	0.2040
LSD 0.05	0.6625	0.9643	1.385
LSD 0.01	0.9132	1.321	1.845

Leaf area per plant (cm): Table 3 lists the results of per plant and its application schedule for maize leaf area affected by nitrogen levels. Analysis of variance showed that the leaf area per plant was significantly affected by nitrogen levels, application schedule, and nitrogen level interaction x administration schedule (P<0.01). It is evident from the results that the largest leaf area (473.92 cm) per plant was recorded in plants fertilized with 180 kg per ha N (N3), followed by 464.44 cm plant- in plants receiving nitrogen fertilizer- Leaf area of 1. The rate was 120 kg per ha (N2); the smallest leaf area of 455.15 cm per plant was observed at a minimum nitrogen content of 60 kg per ha (N1). The timetable for the application of nitrogen fertilizers indicated that in four equal divisional stages (S4), after sowing, harvesting of 25% of nitrogen crops at 14, 28 and 42 days after emergence (DAE) resulted in the largest leaf area (501.95 cm) plant. -1, followed by the average leaf area recorded by the maize plants at 484.66 and 460.43 cm when planted at five divided divisions (S5), and 20% at the time of sowing, at 14, 28, DAE was applied at 42 and 56 and split with 14, 18, 42 and 56 DAE (S6) 8.3, 16.67, 25.0, 33.33 and 16.6% N when seeding nitrogen in five unequal nitrogen's, respectively. When aliquots (S3) were applied, i.e. 33.33%, respectively when seeding was performed at 14 and 28 DAE and 2 splits (S1), the leaf area was reduced to 450.99 and 445.11 cm and decreased by 50 at the time of sowing. % and 50%. They are 14 DAEs. At the time of sowing, the minimum leaf area of plants receiving N in the 3 divisions at 50%, 14% and 25% of 14 and 28 DAE (S2) was 444.49 cm per plant. The results further indicate that the interaction of N3 x S4 results in a maximum leaf area of 512.13 cm per plant, while under the interaction of N1 x S3, the minimum leaf area is 441.91 cm per plant.

Table-3 Leaf area per plant (cm) of maize as affected by the rate and schedule

Scheduling of N application	**Nitrogen Rates**			**Av. for N rates**
	N_1=60 kg per ha	**N_2=120 kg per ha**	**N_2=180 kg per ha**	
S1=50%@sowing 50% 14 DAE	436.14	445.05	454.13	445.11 c
S2=50%@sowing, 25, 25% 14, 28 DAE	435.54	444.43	453.50	444.49 c
S3=33.33% each @ sowing, 14 and 28 DAE	441.91	450.93	460.13	450.99 c
S4=25% each @ sowing, 14, 28 and 42 DAE	491.84	501.88	512.12	501.95 a
S5=20% each @ sowing, 14, 28, 42 and 56 DAE	474.11	483.99	493.87	484.06 b
S6=8.3, 16.6, 25, 33.33 and 16.6% @ sowing, 14, 28, 42 and 56 DAE	451.17	460.37	469.77	460.43 c
Average for scheduling of N application	455.15 c	464.44 b	473.92 a	-

	N rates (N)	**Scheduling of N application (S)**	**N x S**
S.E.±	1.7002	2.4328	2.693
LSD 0.05	6.338	12.520	9.330
LSD 0.01	8.684	17.150	12.08

Number of cobs per plant: The number of cob plants 1 is a yield component that has a linear effect on the yield per unit area. Table 4 gives the number of cobs per plant data and the schedule of nitrogen fertilizer application affected by N levels. Analysis of variance showed that the number of spiked plants 1 was significantly affected by nitrogen levels, the timing of nitrogen application and their interactions ($p<0.01$). The highest number of corn cobs was 1.73 per plant in corn crops fertilized at 180 kg per ha N (N3), followed by corn crops receiving N at a rate of 120 kg per ha (N2), average nitrogen the content is 1.60 cob per plant. However, plant 60 had the least number of cobs (1.47) at the lowest nitrogen content of 60 kg per ha (N1). In the case of nitrogen fertilizer application, the maize crop received nitrogen fertilizer at four equal divisional stages (S4), ie 25% of nitrogen was harvested at 14, 28 and 42 days after emergence (DAE), resulting in the largest corn cob. The number (1.80) can be seen from Figure 1 when the N is applied at 5 equal division numbers (S5), ie at 20% N when seeding, 14, 28, 42 and 56 DAE, respectively, cob number was reduced to 1.67 and 1.66 per plant; and N was in 3 equal divisions (S3), which were 33.33% of 14 and 28 DAEs, respectively, at the time of sowing. The crop obtained N in five unequal divisions (S6), i.e. 8.3, 16.67, 25.0, 33.33 and 16.6% N, 14, 18, 42 and 56 DAE, respectively, at the time of sowing, in 3 divisions Among them, 50% of N and 14% of 25% of N. 28 DAEs (S2) were ranked fourth and fifth respectively with 1.57 and 1.52 mandrel factories. However, the smallest number of cob (1.37) plants 1 were observed in the maize crop, which received N in two equal fractures (S1), 50% each at the time of sowing, and a DAE of 14. The data further showed that the crops under the N3 x S4 interaction produced the largest number of cobs (1.96) per plant, while the smallest numbers of cobs (1.27) per plant were recorded under the N1 x S1 interaction. Statistically, the number of cobs 1 between S3, S4, and S5 or between S2 and S6 was not significantly different ($P > 0.05$), and when these treatments were compared with the rest of the combinations, the difference was significant. With. Nitrogen levels directly affected the number of corns per cob, and the difference between all N values was significant ($p<0.01$).

Table-4 Number of cobs per plant of maize as affected by the rate and schedule

Scheduling of N application	**Nitrogen Rates**			**Av. for N rates**
	N_1=60 kg per ha	**N_2=120 kg per ha**	**N_2=180 kg per ha**	
S1=50%@sowing 50% 14 DAE	1.27	1.73	1.49	1.37 c
S2=50%@sowing, 25, 25% 14, 28 DAE	1.40	1.52	1.65	1.52 b
S3=33.33% each @ sowing, 14 and 28 DAE	1.53	1.66	1.80	1.66 a
S4=25% each @ sowing, 14, 28 and 42 DAE	1.66	1.81	1.96	1.80 a
S5=20% each @ sowing, 14, 28, 42 and 56 DAE	1.54	1.67	1.81	1.67 a
S6=8.3, 16.6, 25, 33.33 and 16.6% @ sowing, 14, 28, 42 and 56 DAE	1.44	1.57	1.70	1.57 b
Average for scheduling of N application	1.47 c	1.60 b	1.73 a	-

	N rates (N)	**Scheduling of N application (S)**	**N x S**
S.E.±	0.0147	0.0208	0.0301
LSD 0.05	0.0939	0.1085	0.1158
LSD 0.01	0.1287	0.1486	0.1542

Number of grains per cob: Table 5 shows the results of corn grain per cob and nitrogen fertilizer application schedules affected by N levels. Analysis of variance showed that the number of grain per cob changed significantly under the influence of nitrogen level, nitrogen application schedule and treatment interaction ($p<0.01$). It can be seen from the results that in the corn crop with the highest nitrogen application level of 180 kg per ha (N3), the number of grains is the highest (347.91) per cob, followed by the nitrogen (N2) of 120 kg per ha containing 237.04. Particle per cob. At the lowest nitrogen content of 60 kg per ha (N1), the minimum amount of grain (307.41) per cob was recorded. The N fertilization program showed that the maize crop received N at four equal divisional stages (S4), ie 25% N at 14, 28 and 42 days after emergence (DAE), resulting in the largest number of grains (337.71) cob- 1. When seeding on 14, 28, 42 and 56 DAEs, apply N in 5 equal divisions (S5), ie 20% N per application, the number of grains is reduced to 334.19 Per cob. The crops received N at five unequal points (S6), 8.3, 16.67, 25.0, 33.33, and 16.6%, respectively, and were aliquoted at 14, 18, 42 and 56 DAE in three equals (S3). In the third and nitrogen application, 33.33% of the seeds were planted, and the DAEs were 14 and 28, respectively, yielding an average number of per cob of 329.95 and 327.25, respectively. The N application rate at the time of 3 seedings was 50%, and the seeding time was 25%, and the 14 and 28 DAEs (S2) ranked fifth with 322.18 grains per cob. However, the lowest number of seeds recorded in the corn crop (313.44) per cob is N in the form of two equal number of divisions (S1), 50% and 14 DAEs at the time of sowing. It was further investigated that the interaction of N3 x S4 produced the largest number of grains (358.81) per cob, while the interaction of N1 x S1 produced the smallest number of grains (294.26) of per cob. Statistically, the difference in grain per cob between S4 and S5 or between S2, S3 and S6 was not significant (P > 0.05), and the difference was significant when these treatments were compared with the rest of the treatment. The difference in nitrogen levels of grain per cob was linearly significant (P<0.01), and the increase in nitrogen content also increased the number of grain per cob.

Table-5 Number of grains per cob of maize as affected by the rate and schedule

Scheduling of N application	**Nitrogen Rates**			**Av. for N rates**
	N_1=60 kg per ha	**N_2=120 kg per ha**	**N_2=180 kg per ha**	
S1=50%@sowing 50% 14 DAE	294.26	313.04	333.03	313.44 c
S2=50%@sowing, 25, 25% 14, 28 DAE	302.46	321.77	342.31	322.18 b
S3=33.33% each @ sowing, 14 and 28 DAE	307.22	326.83	347.70	327.25 b
S4=25% each @ sowing, 14, 28 and 42 DAE	317.04	337.28	358.81	337.71 a
S5=20% each @ sowing, 14, 28, 42 and 56 DAE	313.74	333.77	355.07	334.19 a
S6=8.3, 16.6, 25, 33.33 and 16.6% @ sowing, 14, 28, 42 and 56 DAE	309.76	329.53	350.57	329.95 b
Average for scheduling of N application	307.41 c	237.04 b	347.91 a	-

	N rates (N)	**Scheduling of N application (S)**	**N x S**
S.E.±	1.1293	1.5971	1.823
LSD 0.05	6.951	8.219	8.842
LSD 0.01	9.524	11.26	11.74

Biomass yield (kg per ha): Table 6 lists the data related to corn biomass production per ha affected by nitrogen levels and nitrogen fertilizer application schedule. Analysis of variance showed that biomass production per ha was significantly different (p<0.01) due to different nitrogen levels, the schedule of nitrogen application, and the interaction between nitrogen levels and their application schedule. The highest biomass yield was 15650.33 kg per ha from the corn crop with a maximum nitrogen application level of 180 kg per ha (N3), followed by a nitrogen yield of 120 kg per ha (N2) of average biomass. It is 14241.80 kg per ha. The lowest biomass yield recorded at a minimum nitrogen content of 60 kg per ha (N1) was 13672.13 kg per ha. The N fertilization program indicated that the maize crop received N in four equal divisional stages (S4), ie 25% N was sown on days 14, 28 and 42 after sowing, and the maximum biomass production was 15,968.68 kg per ha. When the biomass was applied with five aliquots

(S5), ie, at the 14th, 28th, 42th, and 56th DAEs, the nitrogen content was 20% and the yield dropped to 15405.68 kg per ha. The crops received N at five unequal points (S6), respectively 8.3, 16.67, 25.0, 33.33, and 16.6% N. 14, 18, 42 and 56 DAE were obtained in three equal divisions (S3). When the third and N were applied, 33.33% were planted, DAE 14 and 28 were ranked 4th, and the average biomass was 15254.74 kg and 14505.03 kg per ha, respectively. The N application rate in the 3 division was 50%, and it was 25% (14 and 28 DAE (S2)) at the time of sowing, ranking fifth, and the average biomass yield was 13472.93 kg per ha. However, the minimum biomass yield of corn crops was 12521.56 kg per ha, and the corn crop received two equal divisions (S1) with 50% and 14 DAE nitrogen at the time of sowing. Interaction studies showed that biomass yield was highest (17210 kg per ha) under N3 x S4 interaction, while the lowest biomass yield was 11789.33 kg per ha under N1 x S1 interaction. Statistically, when these treatments were compared with the rest of the treatment, the differences in biomass yield per ha between S4 and S5. The difference in nitrogen levels in biomass yield per ha was significant (P<0.01), and as the nitrogen content increased, the biomass yield per ha increased in parallel.

Table-6 Biomass yield (kg per ha) of maize as affected by the rate and schedule

Scheduling of N application	**Nitrogen Rates**			**Av. for N rates**
	N_1=60 kg per ha	**N_2=120 kg per ha**	**N_2=180 kg per ha**	
S1=50%@sowing 50% 14 DAE	11789.33	12280.45	13495.00	12521.56 d
S2=50%@sowing, 25, 25% 14, 28 DAE	12684.96	13213.50	14520.33	13472.93 c
S3=33.33% each @ sowing, 14 and 28 DAE	13656.70	14225.72	15632.66	14505.03 b
S4=25% each @ sowing, 14, 28 and 42 DAE	15034.63	15661.10	17210.00	15968.58 a
S5=20% each @ sowing, 14, 28, 42 and 56 DAE	14504.67	15109.03	16603.33	15405.68 a
S6=8.3, 16.6, 25, 33.33 and 16.6% @ sowing, 14, 28, 42 and 56 DAE	14362.56	14961.00	16440.66	15254.74 b
Average for scheduling of N application	13672.13 c	14241.80 b	15650.33 a	-

	N rates (N)	**Scheduling of N application (S)**	**N x S**
S.E.±	100.63	142.32	171.50
LSD 0.05	479.60	732.40	738.70
LSD 0.01	657.10	1003.0	983.80

Grain yield (kg per ha): Table 7 lists the results of corn grain yield per ha and nitrogen fertilizer application plan affected by nitrogen levels. Analysis of variance showed that different nitrogen application rates and nitrogen application schedule had significant effects on grain yield per ha (p<0.01), and the interaction between nitrogen application rate and nitrogen application was not significant (P > 0.05). It can be seen from the data in Table 7 that the crop with the highest nitrogen application rate is 180 kg per ha (N3), then the nitrogen fertilizer is 120, and the highest grain yield is 3030.28 kg per ha. Kg per ha (N2), the average grain yield was 2762.30 kg per ha. At a minimum nitrogen application of 60 kg per ha (N1), the lowest grain yield obtained was 2541.32 kg per ha. The nitrogen fertilizer application plan indicated that the maize crop received nitrogen fertilizer in four equal stages (S4), i.e., 25% of nitrogen was harvested on days 14, 28 and 42 after emergence (DAE), and the maximum grain yield was 3077.65 kg per ha. The ratio of grain to N in the aliquot (S3) at the time of sowing was 33.33%, and the yields of DAE and 20% of N at the time of sowing were 14% and 28, respectively. Dropped to 2838.08 and 2832.44 kg per ha, 14, 28, 42 and 56 DAE, respectively. When five non-sequence splits (S6) were planted, the nitrogen content of the crops was 8.3, 16.67, 25.0, 33.33, and 16.6%, respectively, while the DAE ranked fourth and third with 14, 18, 42 and 56, respectively. There were 50 and 25% of 14 and 28 DAEs (S2) ranked fifth, with average grain yields of 2,967.88 kg and 2,677.93 kg per ha, respectively. However, in corn, the lowest grain yield of 2488.83 kg per ha was obtained in 2 equal portions (S1), 50% seeding per serving and 14 DAE nitrogen content. The treatment interactions showed a significantly higher grain yield (3454.80 kg per ha) under the N3 x S4 interaction and a minimum cereal yield of 2283.43 kg per ha under the N1 x S1 interaction. Statistically, the grain yield per ha difference between S3-S5 or S1-S2-S6 was not significant (P>0.05), and the comparison of these treatments with the rest of the treatment was significant (P<0.01). The nitrogen level of grain yield per ha was linear (P<0.01), and with the increase of nitrogen content, grain yield per ha increased at the same time.

Table-7. Grain yield (kg per ha) of maize as affected by the rate and schedule

Scheduling of N application	**Nitrogen Rates**			**Av. for N rates**
	N_1=60 kg per ha	**N_2=120 kg per ha**	**N_2=180 kg per ha**	
S1=50%@sowing 50% 14 DAE	2284.43	2483.08	2699.00	2488.83 c
S2=50%@sowing, 25, 25% 14, 28 DAE	2458.00	2671.72	2904.06	2677.93 c
S3=33.33% each @ sowing, 14 and 28 DAE	2646.29	2876.41	3126.53	2883.08 b
S4=25% each @ sowing, 14, 28 and 42 DAE	2783.07	3025.08	3454.80	3087.65 a
S5=20% each @ sowing, 14, 28, 42 and 56 DAE	2599.81	2825.88	3071.61	2832.44 b
S6=8.3, 16.6, 25, 33.33 and 16.6% @ sowing, 14, 28, 42 and 56 DAE	2476.31	2691.64	2925.70	2697.88 c
Average for scheduling of N application	2541.32c	2762.30b	3030.28a	-

	N rates (N)	**Scheduling of N application (S)**	**N x S**
S.E.±	30.5698	43.2322	40.304
LSD 0.05	145.80	222.50	198.60
LSD 0.01	209.84	304.80	264.50

DISCUSSION

Corn is the most important crop and has many uses. It is a cereal grain eaten by humans. The oil extracted from corn kernels is used as an edible oil in human food, and corn is also the favorite feed for almost all farm animals. Nitrogen is usually applied directly to produce corn, but with the changes in planting patterns and soil fertility conditions, it is a prerequisite to study the application of nitrogen fertilizer on different schedules. Separate application of nitrogen fertilizer can significantly increase the nitrogen use efficiency of maize, especially during the wet growing season. In the early stages of growth, large amounts of nitrogen may be lost, especially in wet conditions. Therefore, a large allocation of nitrogen fertilizer should be postponed until the vegetative growth is rapid (Augustine and Bright, 2020). This study aimed to investigate the effects of different nitrogen levels and nitrogen application on maize growth and grain yield. Studies have shown that corn with a nitrogen level of 180 kg per ha can produce a plant height of 185.07 cm, leaf per plant 1.94, leaf area per plant 473.92 cm, cob per plant 1.73, grain per cob 347.91, biomass yield of 15650.33 kg and grain yield per ha 3030.28 kg. Among all the growth and yield components, nitrogen ranks second with a ratio of 120 kg per ha, while 60 kg per ha ranks third. The conclusion that 180 kg N per ha is the most effective nitrogen fertilizer application and has the maximum value for all growth and grain traits of corn. Similar findings reported by Naveen and Saikia, (2020) concluded that N:P: K at 120:60:40 kg per ha resulted in the highest grain yield. The conclusion is that when the amount of nitrogen is higher, the yield of corn is greatly increased compared to the lower dose. These results are in complete agreement with the results of this survey. However, the changes are unlikely to be due to soil fertility conditions, the varieties they use and other management methods. The results further showed that nitrogen was applied in four equal portions, applied at 25% at the time of sowing, and ranked first in the 14th, 28th, and 42th DAEs, resulting in plant height of 183.04 cm, a leaf plant of 12.85 cm, and a leaf area plant of 501.95 cm. cob 1.80 cm, 337.71 grain per cob, 15968.58 kg biomass yield and 3087.65 kg grain yield per ha. N is applied in three equal divisions, accounting for 33.33% at the time of sowing, and the 14th and 28th DAEs are ranked second, accounting for 20% of the five equal divisions, respectively, at 14, 28, 42 and 56. Ranked third in the DAE, in the five unequal divisions, 8.3, 16.6. At the time of sowing, they were 25, 33.33 and 16.6% respectively. In the three divisions, the DAE ranked fourth, 14, 28, 42 and 56 respectively, and 50% in the sowing, in two divisions. DAE ranked fifth and N at 25, 25%, and 14, respectively, and ranked fifth in biomass and grain yield per ha for 50% seeding and 50% 14 DAE in the split. From the conclusions of this study, it can beconcluded that planting 180 kg N per ha at four equal divisions yielded 25% DAE, 14, 28 and 42 DAE, respectively, at the time of sowing, which proved to be the most effective in corn production. The most economical way to divide nitrogen fertilizer. Many past workers have reported the results of supporting the findings of this survey. Nitrogen fertilizer 294 kg per ha were applied to corn to increase corn yield. Jørgensen *et al*., (2020) applied 300 kg per ha N per ha under various fractionation and reported the largest corn kernel yield. Han *et al*., (2020) used different nitrogen partitioning methods for maize and reported that fertilizer treatment did not significantly affect the number of plants and ears but had a significant impact on grain and straw yield. Chisanga *et al*., (2020) reported that there were significant differences in grain yields under different levels of NPK and application, i.e., the arrangement of fractional applications had a significant impact on crop index. Similarly, Wade *et al*., (2020) also reported a significant effect of nitrogen fertilizer allocation on corn grain yield. Similarly, Fernandez, (2020) reported the effects of pre-planting and nitrogen application on maize yield and found that nitrogen application before planting was significantly higher (7.6-10.6%) than before corn planting. A comparative analysis of the results of this study and the results reported by other researchers around the world indicates that, because of changes in planting patterns and rapid deterioration of soil fertility, it is necessary to change the way of nitrogen fertilizer application to improve soil fertility and increase maize nitrogen use efficiency.

Conclusions

It was concluded from the findings of the present experiment that 180 kg N per ha proved to be the most effective Nitrogen (N) application rate with maximum values for all the growth and grain yield traits of maize when applied in four equal splits, 25% each time 14, 28 and 42 days after emergence (DAE).

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