Effect of planting density and nitrogen levels on the yield attributing characters of fodder maize (Shalimar Fodder Maize-1)

Abstract

Maize (*Zea mays* L.) is widely known as a ready-made fodder crop. Maize is the third major cereal crop in the world, and in India, it ranks third. Maize has been an important cereal crop owing to its highest production potential and wider adaptability to varied agroclimatic conditions, hence being called the 'Queen of Cereals'. The production potential of forage maize can be altered with changes in agronomic practices. The present study was undertaken with the objective of improving the yield attributes and quality traits of forage maize (Shalimar Fodder Maize-1). The experiment consisted of two factors, viz., three planting densities (D_1= 30cm x 10cm, D_2= 40cm x 10cm, and D_3= 50cm x 10cm) as main plots, and five nitrogen levels (N_1= Control, N_2= 75% RDN (recommended dose of nitrogen), N_3= 100% RDN, N_4= 125% RDN, and N_5= 150% RDN), as subplot treatments with three replications, laid out in split plot design (SPD). The parameters such as yield attributes, and quality parameters were significantly higher when plants were grown at a density of 30 cm x 10 cm with a nitrogen level of 150 % RDN.

Keywords: Maize, *Zea mays* L.,Planting densities, Nitrogen levels, Growth parameters.

1. Introduction

Maize, scientifically known as *Zea mays* L., holds a prominent status as a readily available fodder crop. Ranking third globally among major cereal crops and following wheat and rice in India, maize stands out for its remarkable production capacity and adaptability to diverse agroclimatic environments, earning it the title of the 'Queen of Cereals'[1. Globally maize is grown on an area of about 193.7 million hectares with a production and productivity of about 1147 million MT and 5.75 t ha^{-1} respectively [2]. In the Union Territory of Jammu and Kashmir, maize is the second most important cereal crop after rice and is grown in an area of 0.31 million hectares with a production of 0.51 million tonnes with average productivity of 1.6 t ha^{-1} [3].

The production potential of maize as a convenient crop for forage is significant due to several factors. Maize yields high quantities of green fodder per unit area, ranging from 12 to 25 total dry matter t ha^{-1} (Mandic *et al*., 2013). This is attributed to its high energy content in dry matter and quality biomass suitable for silage, making it a preferred choice over other cereal forages. Maize stands out for its rich non-structural carbohydrate content, particularly favoured in silage production, rendering it highly nutritive and sustainable for livestock fodder (Iqbal *et al*., 2006).

Agricultural practices, particularly planting density and nutrient management, play crucial roles in altering maize forage yield attributing and quality traits. The response of maize to planting densities varies with environmental conditions and cultural practices. Higher planting densities are generally favourable for forage compared to grain crops (Jat *et al.*, 2017). Nutrient management, especially fertilizer application, significantly influences maize growth and development. Adequate nutrient supply at each growth stage is essential for optimal growth. Nitrogen, being the most crucial element required in larger amounts, enhances overall growth and development, contributing to improved fodder quality and protein content in grains (Subedi and Ma, 2009). Taking into account these considerations, the present study aims to enhance growth attributing traits in maize forage.

2. Materials and methods

The study was carried out at Faculty of Agriculture, SKUAST-K, Wadura, Sopore during the *kharif* season. The experiment consisted of two factors, viz., three planting densities (viz., D_1= 30cm x 10cm, D_2= 40cm x 10cm, and D_3= 50cm x 10cm) as main plots and five nitrogen levels (viz., N_1= Control, N_2= 75% RDN (recommended dose of nitrogen), N_3= 100% RDN, N_4= 125% RDN, and N_5= 150% RDN) as subplot treatments with three replications, laid out in split plot design (SPD). The genotype used during this study was Shalimar fodder maize-1 (SFM1).

The observations, plant population was recorded at harvesting time by calculating number of plants in a particular row (leaving border and penultimate rows) and the population was recorded in plants m^2.The fodder yield of each net plot (leaving border and penultimate rows) was harvested and weight from each plot was recorded separately as kg $plot^{-1}$ and then converted into q ha^{-1}.

Among the quality studies, the nitrogen (N) content was estimated by the modified micro Kjeldahl procedure and expressed in percentage. Protein content was calculated from the N content by multiplying with a factor 6.25.The concentrations of neutral detergent fibre (NDF %) and acid detergent fibre (ADF %) were determined using proximate analysis (Van Soest fibre analysis, Goering and Van, 1970).

Theinvitro dry matter digestibility(IVDMD%) was determined by the method described by (Tilley and Terry, 1963; Harris, 1970).The total ash was calculated by the following formula and expressed in percentage.

$$\text{Total ash } (\%) = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

3. Results and discussion

3.1.Plant population (plants m^{-2})

Plant population (plants m^{-2}) was recorded at the harvesting of the crop and the results determined that planting density had significant effect on plant population recorded at harvesting. Planting density 30 cm x 10 cm recorded the highest plant population (32.88) m^{2} than other planting densities. The plant population recorded among different nitrogen levels were non-significant where 150% RDN recorded higher plant populations (26.09) m^{2} as compared to other levels (Table 1).

Seeds sown with increasing planting densities resulted the increase in plant population. Highest plant population was recorded at 30 cm x 10 cm compared to rest of treatments. These results are in accordance with the findings of Ayub *et al*. (2002) and Ayub *et al*. (2007). The 150 % RDN recorded the highest number of plants per unit area. This can be explained by an increase in overall growth and health of plants by nitrogen which in turn contributes to better plant stand. Moreover, nitrates are capable of breaking seed dormancy as observed by Sexsmith *et al.* (1963) in wild oats. Duermeyer *et al.* (2018) also concluded that nitrate promotes seed germination in many plant species and functions as a nutrient for better plant stand.

3.2.Green fodder yield (q ha^{-1})

The green fodder yield was significantly influenced by planting densities and nitrogen levels. The planting density of 30 cm x 10 cm recorded maximum green fodder yield (519.32 q ha^{-1}) and the lowest green fodder yield (384.57 q ha^{-1}) was obtained on 50 cm x 10 cm.With regards to nitrogen levels, 150% RDN recorded maximum green fodder yield (538.89 q ha^{-1}) whereas lowest green fodder yield (323.17 q ha^{-1}) was recoded with control (N_1) (Table 1).

The planting density of 30cm x 10 cm recorded the highest green fodder yield than other two planting densities. Subrahmanya *et al.* (2017) found that the seed rate of 60 kg ha^{-1} increased the green fodder yield which was 19% higher than 45 kg ha^{-1} seed rate. Meena *et al*. (2022) also observed that narrow row spacing of 20 cm produced higher green fodder yield as compared to 30 cm and 40 cm spacing.Among nitrogen levels, the highest green fodder yield with application of 150% RDN. These results corroborate the findings of Panwar *et al.* (2020) who observed higher green fodder yield under the application of 130 kg N ha^{-1} which was significantly higher over 110 kg Nand 90 kg ha^{-1}.

3.3.Crude protein content (%)

The planting densities impact a statistically non-significant effect on crude protein content, while protein content differed significantly among nitrogen levels. Higher protein content reported in planting density of 30 cm x 10 cm while as lowest protein content obtained in 50 cm x 10 cm planting density.150 % RDN significantly recorded the highest protein content (9.75 %) than 125 % RDN and 100 % RDN respectively. Control recorded the lowest protein content (Table 2).

The planting density 30 cm x 10 cm registered the highest crude protein content over other planting densities. Mehdi*et al.* (2012) also studied the effect of plant density on crude protein of maize and observed that the total crude protein content was not significantly influenced by the seed rate. Among nitrogen applications, 150 % RDN being superior among nitrogen levels obtained the highest crude protein content. Ullah *et al.* (2015), Mehdi *et al.* (2012) and Eltelib *et al*. (2006) also observed that an increase in nitrogen levels increases the crude protein content. This might be due to the fact that plant has a large concentration of nitrogen at higher N levels which in turn accelerates the production of nucleotides and coenzymes for protein synthesis (Kakol *et al*. 2003).

3.4.Neutral detergent fibre (NDF %) and acid detergent fibre (ADF %)

The neutral detergent fibreand acid detergent fibre differed significantly with respect to planting densities and nitrogen levels. Planting density of 30 cm x 10 cm registered significantly higher neutral detergent fibre (68.25 %)and acid detergent fibre (45.65 %) respectively. While the lowest neutral detergent fibre (64.65%)and acid detergent fibre (41.33 %) were recorded in 50 cm x 10 cm sowing.Among nitrogen levels, both neutral detergent fibreand acid detergent fibre were seen to be decreasing with an increase in nitrogen levels where control (N_1) reported the highest neutral detergent fibre (68.23 %)and highest acid detergent fibre (45.24 %) respectively than other nitrogen levels. While as lowest neutral detergent fibre (65.31%)and acid detergent fibre (42.25 %) were recorded in 150 % RDN (Table 2).

The contents of neutral detergent fibre (NDF) and acid detergent fibre (ADF) are mainly composed of cellulose, lignin, hemicellulose, ash and N compounds. This decrease in NDF and ADF values might be due to the production of plants with soft stems and leaves dueto a higher plant population per unit area. (Kumar *et al*., 2017) also reported a decrease in NDF and ADF content with an increase in seed rate.Among nitrogen levels 150 % RDN recorded the lowest NDF and ADF than other nitrogen levels. The results are in conformity with Muller *et al.* (2005) who observed reduced NDF and ADF contents with increased planting density. Almodares *et al.* (2009) also reported a reduction in fibre contents with an increase in nitrogen levels.

3.5.Invitro dry matter digestibility (IVDMD %)

Planting density of 30cm x 10cm registered significant higher invitro dry matter digestibility (58.21%) while as lowest invitro dry matter digestibility (56.29 %)was recorded in 50cm x 10cm planting density.Among nitrogen levels, 150% RDN reported highest invitro dry matter digestibility (58.89%) and was at par with 125% RDN (Table 2).

This improvement in IVDMD might be due to the decrease in lignin content due to the denser canopy. Cherney *et al.* (1991) and Yosef *et al.* (2009) reported that an increase of 1 % in forage lignin content is accompanied by a reduction of 4 % in its IVDMD values. Increase in nitrogen levels resulted in increased IVDMD and 150 % RDN recorded the highest value. This might be due to decrease in amount of fibre contents with increase in nitrogen levels which in turn increases digestibility. In the same way, Sindhu *et al.* (2006) also observed that IVDMD increased with increase in nitrogen levels.

3.6.Ash content (%)

The ash content was non significantly influenced by planting densities and nitrogen levels. 30cm x 10cm planting density recorded the highest ash content (8.44 %). The lowest ash content (8.33 %) was noticed at 50 cm x 10 cm.150 % RDN registered the highest ash content (8.61 %) and was statistically superior to other genotypes. It was followed by 125 % RDN and 100 % RDN respectively (Table 2).

However, results showed that 30 cm x 10 cm planting density has highest ash content compared to rest of treatments. The improvement in ash content may be contributed by more dry matter content which improved the uptake of nutrients by the plants. 150 % RDN recorded the highest ash content and is attributed to the higher dry content matter which improved mineral matter.Saruhan and Sireli (2005) also observed that ash content of foddermaize increased with an increase in nitrogen dose from 90 kg ha^{-1} to 120 kg ha^{-1}.

4. Conclusions

The maximum green fodder yield was also recorded at a density of 30 cm x 10 cm with a nitrogen level of 150 % RDN. The quality parameters were also superior with a nitrogen level of 150 % RDN and planting density of 30 cm x 10 cm.

The results lead to the conclusion that, to obtain higher yield attributes, green fodder yield and quality parameters of fodder maize under Kashmir valley conditions the fodder maize (SFM-1) should be cultivated with a planting density of 30 cm x 10 cm and nitrogen level of 150 % RDN.

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Appendix

Table 1:Plant population at harvest (plants m^{-2}) and green fodder yield (q ha^{-1}) of

Treatments	Plant population (plants m^{-2})	Green fodder yield (q ha^{-1})
	Planting Density	
D_1	32.88	519.32
D_2	24.51	446.56
D_3	19.45	384.57
SE(m)±	1.64	7.13
CD (p≤0.05)	3.97	22.48
	Nitrogen levels	
N_1	24.61	323.17

Shalimar Fodder Maize-1 under varied planting density and nitrogen levels

N_2	25.56	401.28
N_3	25.83	474.93
N_4	25.99	525.47
N_5	26.09	538.89
SE(m)±	0.002	9.32
CD (p≤0.05)	0.005	31.21

Table 2:Quality parameters of Shalimar Fodder Maize-1 under varied planting density and nitrogen levels

Treatment	Crude protein (%)	NDF (%)	ADF (%)	IVDMD (%)	Ash content (%)
Planting density					
D_1	9.15	64.35	41.65	58.21	8.44
D_2	9.08	66.56	43.69	57.18	8.24
D_3	9.03	68.65	45.33	56.29	8.33
SE(m)±	0.07	0.17	0.168	0.11	0.13
CD (p≤0.05)	**NS**	**0.69**	**0.677**	**0.45**	**NS**
Nitrogen levels					
N_1	9.0	68.23	45.24	55.26	8.16

N_2	9.21	67.31	44.27	56.40	8.28
N_3	9.43	66.27	43.41	57.42	8.35
N_4	9.65	65.47	42.62	58.16	8.50
N_5	9.75	65.31	42.25	58.89	8.61
SE(m)±	0.04	0.34	0.44	0.34	0.12
CD ($p \leq 0.05$)	**0.14**	**1.008**	**1.30**	**0.99**	**NS**