Original Research Article

Effect of sowing dates and nitrogen levels on growth, yield, quality and economics of Fodder maize (*Zea mays* L.) SFM-1

ABSTRACT

The study aimed to assess the effect of sowing dates and nitrogen levels on yield, yield attributes quality, and economic return of Shalimar Fodder Maize-1 (*Zea mays* L.). An experiment was carried out at Crop Research Farm of the Division of Agronomy, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Wadura, during Kharif 2022. The experiment consisted of four sowing dates, S_1 (15th April), S_2 (15th May), S_3 (15thJune), and S_4 (15th July) and four nitrogen levels, N_0 (0 kg ha^{-1}), N_1 (60 kg ha^{-1}), N_2 (120 kg ha^{-1}) and N_3 (180 kg ha^{-1}) as sub-plot treatments, laid out in a split-plot design with three replications. The results showed that the early date of sowing S_1 (15th April) had significantly higher values in yield, yield attributes, and quality parameters *viz.*, number of leaves per plant, dry matter accumulation, green fodder yield, dry fodder yield, crude protein content (%), ADF (%), NDF (%), and ash content (%) than other sowing dates, while S_4 (15th July) had significantly lower growth, yield, and quality parameters. However, S_1 (15th April) recorded a significantly lower leaf stem ratio, which was seen to be decreasing with an increase in sowing dates. Among different nitrogen levels, the yield and quality parameters *viz.*, leaf stem ratio, number of leaves per plant, dry matter accumulation, green fodder yield, dry fodder yield, crude protein, and ash content were significantly influenced by increasing levels of nitrogen, being maximum with N_3 (180 kg ha^{-1}), which was at par with N_2 (120 kg ha^{-1}), whereas N_0 (control) recorded significantly lower growth, yield, and quality parameters. Furthermore, NDF (%) and ADF (%) decreased as nitrogen levels increased, and were lowest at N_3 (180 kg ha^{-1}). In terms of economic suitability, the treatment combination of S_1N_3 (15th April + 180 kg ha^{-1}) had the highest net returns (Rs. 143841.7 ha^{-1}) and benefit: cost ratio (2.87), followed by S_1N_2 (15th April + 120 kg ha^{-1}) with net return (Rs. 120721.3 ha^{-1}) and benefit: cost ratio (2.45).

Keywords: Fodder maize, Sowing dates, Nitrogen levels, Yield, Quality, Economic return.

INTRODUCTION

Maize crop has an important place in the food grain basket of our country and is the third most important food crop because of its importance in food, feed, fodder, speciality corn, starch etc. It has yield potential far higher than any other cereal hence referred to as the miracle crop or the "Queen of Cereals". In the world, nearly 1147.7 million tonnes of maize are being produced together by over 170 countries from an area of 193.7 million hectares with average productivity of 5.75 t ha^{-1} (FOASTAT, 2020). It has attained a position of industrial crop globally as 83% of its production in the world is used in feed, starch and biofuel industries. The global consumption pattern of maize is feed 61%, food 17% and industry 22%. It is a prime driver of the global agricultural economy (FOASTAT, 2020). India ranks fourth in area and seventh in production among maize-growing countries, encompassing around 4% of global maize area and 2% of total production. During 2018-2019 in India, the maize area has reached to 9.2 million hectares (DACNET, 2020). During 1950-51, India had only 1.73 million MT of maize, which has increased to 27.8 million MT, representing an almost 16-fold increase in production. The average productivity during the period has increased by 5.42 times from 547 kg ha^{-1} to 2965 kg ha^{-1}, while the area increased nearly by three times. Maize is the second most important cereal crop after rice in the Union Territory of Jammu and Kashmir, grown on an area of 0.31 million hectares with a production of 0.51 million tonnes and an average productivity of 1650 kg ha^{-1} (DES, 2019). In the union territory of Jammu and Kashmir, about 90.6% of the total area under maize is planted under rainfed conditions (DES, 2017). India ranks fourth in area and seventh in production among maize-growing countries, encompassing around 4% of global maize area and 2% of total production. During 2018-2019 in India, the maize area has reached to 9.2 million hectares (DACNET, 2020). During 1950-51, India produced only 1.73 million MT of maize, which has increased to 27.8 million MT, representing an almost 16-fold increase in production. The average productivity during the period has increased by 5.42 times from 547 kg ha^{-1} to 2965 kg ha^{-1}, while the area increased nearly by three times. Maize is the second most important cereal crop in the union territory of Jammu and Kashmir, after rice, and is grown on an area of 0.31 million hectares, with a production of 0.51 million tonnes and an average productivity of 1650 kg ha^{-1} (DES, 2019). In the union territory of Jammu & Kashmir, about 90.6% of the total area under maize is grown under rainfed circumstances (DES, 2017).

Maize (*Zea mays* L.) is considered an important double-purpose crop (used in the human diet as grain as well as animal feed) grown widely in the *kharif* season. Maize is generally sown under rainfed conditions and in marginal areas, particularly in hilly terrains of the Kashmir valley invariably as an intercrop with pulses. Maize requires considerable moisture and temperature from germination to flowering. The ideal temperature for germination is 21℃, whereas for growth it is 32℃. Maize is quite sensitive to stagnant water, especially in the early phases of growth (Chaudhary *et al.*, 2012).

Maize forage supplies a substantial amount of energy-rich forage for dairy animal diets, free from anti-nutritional factors unlike sorghum so can be fed to cattle at any growth stage (Darmardeh *et al.*, 2009). Forage maize has recently become a crucial component of ruminant rations, as it enriches dairy cow diets and improves animal performance (Anil *et al.*, 2000 and Cusicanqui *et al.*, 1999). The maize crop has many desirable fodder qualities, such as high productivity, high production potential, broader adaptability, rapid growing nature, succulence, palatability, toxin-free, rich in protein and minerals, and high digestibility, which makes it preferred over other cultivated non-fodder crops, resulting in increased body weight and milk quality in cattle (Sattar *et al.*, 1994). Hence it is widely known as a ready-made fodder crop. Maize is highly nutritive, excellent and sustainable fodder for livestock (Iqbal *et al.*, 2006). The green fodder of maize possesses lactogenic properties and therefore, is suited for milch cattle (Valk, 2000). Maize possesses high soluble sugar concentrations in the green stage, making it suitable for silage preservation, and it is referred to as the king of crops for silage-making.

Sowing time of maize varies from place to place, especially at different altitudes in Kashmir. Sowing time of maize in lower belts of Kashmir ranges from last week of April to mid of May. There is the modifying effect on the growth and development of maize plants with the environmental changes (sunshine, temperature) associated with different sowing dates. Sowing dates had a significant effect on maize growth and yield. Greater the deviation from the optimal maize sowing date, higher the reduction in yield (Sarvari *et al.*, 2000; Berzsenyi and Lap, 2001). One of the challenges for maize growers present is to find the narrow interval between sowing earlier and sowing later (Nielsen *et al.*, 2002). Lower yield is obtained when seeds are sown too early or late, probably due to the presence of unfavourable climatic conditions before or after the growing season. Maize sown earlier performs better and produces better yields due to the fact that the vegetative phase of the life cycle occurs during the colder part of the season with less moisture stress (Ali *et al.*, 2014). Late sowing reduces maize production by shortening the effective growing season, reducing crop photosynthesis, and exposing the crop to high-risk lethal cold temperatures before grain maturation, insect and disease stress, and moisture and heat stress during pollination (Otegui and Melon, 1997). Sowing time is such a changeable element of agro-technique which does not require extra cost however, we can manage it to increase the efficiency of crop. In addition to recommended agro-management measures, choosing an appropriate sowing date with a good variety guarantees higher maize production (Qureshi *et al.*, 2007). For achieving higher efficiency from available nutrients, water and solar energy, the selection of optimum sowing date for already existing varieties is unavoidable (Ogbomo and Remison, 2009).

Fertilizer application is one of the principal factors that directly influence fodder yield and quality. An adequate supply of nutrients at each growth stage is highly essential for improving yield and quality of fodder maize. Nitrogen is the most important essential element for plants and is required in a comparatively large amount. It is the basic constituent of chlorophyll, protoplasm, amino acids and nucleic acids. It enhances the growth and development of all living tissues and helps in improving the quality of fodder and the protein content of grains. It is the most important element yield-limiting factor in agricultural systems (Subedi and Ma, 2009). It is mainly supplied through mineral fertilizers, farm manure, symbiotic nitrogen fixation, and atmospheric wet and dry deposition. It is very essential for plant growth and makes up 1 to 4% of plant dry matter. It also mediates the utilization of phosphorus, potassium, and other elements in plants.

Therefore, a field investigation was conducted to evaluate the effect of dates of sowing and nitrogen levels on yield attributes, yield, quality and economics of fodder maize (*Zea mays* L.) SFM-1 under conditions of Kashmir valley.

MATERIALS AND METHODS

The experiment was conducted at the Crop Research Farm of Division of Agronomy, Faculty of Agriculture Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Wadura Sopore during *Kharif*, 2018. The site is located between 34º 21′ N latitude and 74º 23′E longitude and has an altitude of 1590 m above mean sea level. The experimental site was well-drained with uniform topography. The experimental site falls in a mid to high altitude characterized by a temperate climate with hot summers and severe cold winters. The average annual precipitation is 812 mm most of which is received from December to April in the form of snow and rains. The soil of the experimental field was silt clay loam in texture with slightly acidic to neutral pH, medium in organic carbon, normal electrical conductivity and the available nitrogen, phosphorus and potassium were also found medium.

The experiment comprised of factors with four sowing dates *viz.*, S_1 (15th April), S_2 (15th May), S_3 (15th June) and S_4 (15th July) as main plot treatments and four nitrogen levels *viz.*, N_0 (0 kg ha^{-1}), N_1 (60 kg ha^{-1}), N_2 (120 kg ha^{-1}) and N_3 (180 kg ha^{-1}) as sub-plot treatments laid out in split plot design with three replications. The total number of treatment combinations was 16 and the total number of treatment plots was 48. The gross plot size of each subplot was 15 m^2 and the net plot size of each subplot was 15.8 m^2.

Leaf stem ratio: Five plants from each plot were taken from the base and the leaves were separated from the stems of each plant for the leaf stem ratio. The leaves and stems from each plot were sun-dried and weighed individually. The leaf to stem ratio was then computed as

$$\text{Leaf stem ratio} = \frac{Dry\ weight\ of\ leaves}{Dry\ weight\ of\ stem}$$

Number of leaves plant^{-1}: Five plants were selected randomly to count the number of leaves. The number of green leaves considered as leaves plant^{-1} was recorded at 30 DAS, 60 DAS, and harvest.

Dry matter accumulation: Plant samples were randomly selected from the penultimate rows of each plot at 30 DAS, 60 DAS, and harvest. The samples were cut from the base with a knife when they were small, and then with a sickle when they grew bigger. These samples were dried in the oven for 4-6 days to obtain a constant weight at temperatures ranging from 60-65°C. The weight was recorded in grams and then converted to q ha^{-1}.

Green fodder yield: The green fodder yield of each net plot (leaving the border and penultimate rows) was harvested, and the weight from each plot was recorded individually as kg plot^{-1}, which was further converted into q ha^{-1}.

Dry fodder yield: The fresh fodder yield of each net plot was allowed to sundry for about a week and weight was recorded in kg and converted to q ha^{-1} to determine the dry weight ha-1.

Crude protein: The nitrogen (N) concentration was assessed by using the modified micro-Kjeldahl technique and expressed in percentage. Protein content was estimated by multiplying the N content by a factor 6.25.

Ash content: The ash content of ground samples was evaluated using the method described by (AOAC, 1995). The following formula was used to calculate the total ash, which was then expressed in percentages.

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

ADF and NDF (%): The concentrations of neutral detergent fiber (NDF) and acid detergent fiber (ADF) were measured using proximate analysis (Van Soest fiber analysis, Goering and Soest, 1970). When a sample is boiled (refluxed) in a neutral detergent solution for an hour, all the cell contents dissolve completely. The residue left after boiling is known as cell wall content. To determine the percentage of cell wall content in a sample, the cell wall content is dried overnight at 100-105°C and then weighed. Cell content is determined by the difference, *i.e.*, % cell content = 100 - % cell wall content.

Calculation:

Weight of sample = W_1 g

Weight of empty crucible = W_2 g

Weight of crucible + NDF = W_3 g

Weight of NDF = (W_3-W_2) g

$$(\%\ of\ NDF) = \frac{W_3 - W_2\ X\ 100}{W_1}$$

When the sample is boiled in an acid detergent solution for an hour, all the cell content and hemicellulose dissolve completely. The residue left after boiling is known as acid detergent fiber. The acid detergent fiber (ADF) is then dried and washed to find out the ADF % in the sample.

Calculation:

Weight of sample = W_1 g

Weight of empty crucible = W_2 g

Weight of crucible + ADF = W_3 g

Weight of ADF = (W_3-W_2) g

$$(\%\ of\ ADF) = \frac{W_3 - W_2\ X\ 100}{W_1}$$

Relative economics: The economics of various treatments were calculated using the cost of cultivation, gross return, net return, and benefit-cost ratio. The cost of cultivation was calculated for each treatment based on the price of input. The gross return was calculated based on the existing price of the output. The benefit-cost ratio was then determined to estimate the profitability of the per-rupee investment.

Net returns = Gross returns – Total cost of cultivation

Benefit: cost ratio = Net returns ÷ Total cost of cultivation

RESULTS AND DISCUSSION

Effect of sowing dates

Growth and Yield

Data showed that sowing dates have a significant effect on leaf stem ratios taken at 30-day intervals. A perusal of the data in Table 1 showed that the leaf stem ratio was higher on the 15th July (S_4) sowing than the rest of the sowings up to 30 DAS. However, at 30 DAS, the sowing date of 15th April (S_1) had a higher leaf stem ratio (0.51 cm) than the rest of the sowing dates. The highest leaf: stem ratio was obtained on the 15th of April (S_1) compared to other sowing dates, which was mostly due to more stem weight and less leaf weight in comparison to the other sowing dates. Saimaheshwari *et al.* (2020) found that delay in sowing significantly decreased leaf stem ratio. However, up to 30 DAS, 15th July (S_4) exhibited the highest leaf stem ratio compared to the other sowing dates and is contributed by more stem weight and more leaf weight initially.

The data in Table 1 showed that the number of leaves plant^{-1} was significantly affected by the sowing dates recorded at different stages. Sowing on 15th April (S_1) resulted in the highest number of leaves per plant (14.02) while sowing on July 15th (S_4) obtained the lowest number of leaves per plant. It might be due to the presence of ideal growing conditions at the time of sowing. The number of leaves per plant decreased with delayed sowing due to a reduction in photoperiod. The results are comparable to the findings of Beiragi *et al.* (2011), who discovered that delayed planting decreased the total number of leaves per plant. Similarly, Martin and Williams (2008) discovered that delayed sowing results in a decrease in leaf number per plant and slower rates of leaf appearance.

The data on dry matter accumulation presented in Table 1 demonstrated that the sowing date had a significant effect on dry matter accumulation. Sowing date of 15th April (S_1) recorded the highest dry matter accumulation than the rest of the sowing dates. The reason might be attributed to the exploitation of favourable climatic conditions at important stages of growth by the 15th April (S_1) sown crop, and higher leaf number, which might have provided more photosynthetic area (LAI) and contributed more dry matter. The lowest dry matter accumulation was observed on July 15th (S_4) sowing may be due to unfavourable growth conditions. Girijesh *et al.* (2011) revealed that earlier and timely sowing significantly increases dry matter production in maize crops due to the adequate growing period available during the growth phase, compared to delayed sowing. Cirilo and Andrade (1994) and Maddonni *et al.* (2004) found that delayed maize sowing reduces dry matter yield. However, the 15th of July (S4) sowing exhibits a higher dry matter content up to 30 DAS than other sowing dates due to considerably greater temperatures, which accelerated growth initially.

The data regarding green fodder yield is presented in Table 2 which indicates that green fodder yield was significantly influenced by sowing dates. Sowing on April 15th (S_1) resulted in the highest green fodder yield (520.33 q ha^{-1}), whereas sowing on July 15th (S_4) resulted in the lowest green fodder yield (382 q ha^{-1}).

Crops sown earlier got more time to utilize available resources and favourable temperature at later growth stages of the crop, whereas late sown crops got less time to utilize growth factors, which is responsible for lower leaf area index and stunted plant growth, which decreases dry matter production and insufficient assimilate partitioning towards sink for superior vegetative growth, resulting in a reduction of yield and yield contributing elements in comparison to timely sown crop. Similar findings were reported by Varma *et al.* (2013) and Shargi *et al.* (2011).

The data on dry fodder yield in Table 2 indicated that sowing date had a significant effect on dry fodder yield. Among sowing dates, 15th April (S_1) recorded the highest dry fodder yield (208.12 q ha^{-1}), while 15th July (S_4) recorded the lowest dry fodder yield (152.80 q ha^{-1}). A decrease in dry fodder yield was recorded with successive delays in sowing time. Lower fodder yield in late-sown forage maize could be due to less forage production as a result of lower temperatures at the early growth stages in late-sown crops compared to early-sowed crops. Dar *et al.* (2014) similarly found that early sowing resulted in higher forage yield than late sowing, which they attributed to the available congenial temperature for better growth and development of forage maize.

Quality parameters

The data regarding crude protein content is given in Table 3 which indicates sowing dates had a statistically non-significant effect on crude protein. The highest protein content (9.23%) was obtained on April 15th (S_1), while the lowest protein content (8.90%) was recorded on July 15th (S_4) sowing date. Sowing fodder maize on April 15th (S_1) registered the highest protein content, whereas sowing on July 15th (S_4) showed the lowest crude protein content. Since protein content is inversely proportionate to green fodder yield and the genetic character of the plant remained non-significant among all the dates of sowing. Darby and Lauer (2002) observed that delayed sowing results in low forage quality. Mokhtarpur et al. (2008) discovered that delayed sowing had an inverse effect on protein content, and the highest protein content was observed in early sowing.

The data presented in Table 3 indicated that neutral detergent fiber and acid detergent fiber differed significantly with respect to sowing dates. Sowing on 15th April (S_1) reported significantly higher neutral detergent fiber (69.23%) and acid detergent fiber (46.98) respectively. While the lowest neutral detergent fiber (62.61%) and acid detergent fiber

(38.98%) were determined on 15th July (S_4) sowing. Early sowing increases (NDF%) and (ADF%) because the crop sown earlier attains full maturity because of the favourable temperature during the growing period of 1st sowing, the crop attained the maximum plant height, plant dry weight which favours the maximum ADF and NDF resulting in more accumulation of lignin, cellulose and hemicellulose in forage than late sowing in which the crop does not attain full maturity thus resulting in lower neutral detergent fiber (NDF%) and acid detergent fiber (ADF%) in forage. Salama (2019) discovered that neutral detergent fiber and acid detergent fiber are dependent on the age of the plant at harvest and increase with maturity, so the age of plants at harvest varies with different sowing dates, which consequently increases or decreases the neutral detergent fiber and acid detergent fiber in forage. Similar conclusions were drawn by Gaile (2008) and Ball *et al.* (2001).

The data on ash content in Table 3 demonstrated that sowing dates had a significant effect on ash content. The highest ash level (8.73%) was observed on the 15th of April (S_1). The sowing date of the 15th of July (S_4) resulted in the lowest ash content (8.31%). The highest ash content on April 15th (S1) may be attributed to increased dry matter content, which improved the nitrogen uptake by the plants. Koca *et al.* (2014) revealed that early sowing results in higher ash content than late sowing.

Table 1: Effect of sowing dates and nitrogen levels growth of Shalimar Fodder Maize-1

Treatments	Leaf stem ratio			Number of leaves plant^{-1}			Dry matter accumulation (q ha^{-1})		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
Main plot Dates of sowing									
S_1 (15th April)	0.99	0.89	0.51	5.64	12.15	14.02	23.20	106.70	162.07
S_2 (15th May)	1.12	0.80	0.44	6.14	11.42	12.85	27.18	99.85	147.73
S_3 (15th June)	1.21	0.71	0.37	6.65	10.69	11.84	30.81	93.89	136.53
S_4 (15th July)	1.30	0.61	0.30	7.15	9.97	10.83	33.23	88.49	127.75
SEm±	**0.02**	**0.02**	**0.01**	**0.14**	**0.19**	**0.28**	**1.02**	**1.58**	**2.19**
CD (p≤0.05)	**0.08**	**0.08**	**0.06**	**0.49**	**0.70**	**1.00**	**3.62**	**5.59**	**7.75**
Sub plot Nitrogen levels									
N_0 (0 kg ha^{-1})	1.07	0.61	0.32	4.13	7.23	8.45	16.15	82.00	124.38
N_1 (60 kg ha^{-1})	1.13	0.73	0.38	6.49	11.72	13.04	27.65	96.47	142.13
N_2	1.19	0.81	0.44	7.19	12.38	13.73	33.75	102.88	150.36

(120 kg ha^{-1})									
N_3 (180 kg ha^{-1})	1.23	0.86	0.48	7.76	12.90	14.33	36.87	107.57	157.21
SEm±	**0.01**	**0.02**	**0.01**	**0.19**	**0.21**	**0.23**	**1.14**	**1.61**	**2.33**
CD (p≤0.05)	**0.05**	**0.07**	**0.05**	**0.58**	**0.65**	**0.68**	**3.35**	**4.74**	**6.86**

Table 2: Effect of sowing dates and nitrogen levels on yield of Shalimar Fodder Maize-1

Treatments	Green Fodder Yield (q ha^{-1})	Dry Fodder Yield (q ha^{-1})
Main plot Dates of sowing		
S_1 (15th April)	520.33	208.13
S_2 (15th May)	489.22	195.68
S_3 (15th June)	441.44	176.57
S_4 (15th July)	382.00	152.80
SEm±	**9.03**	**3.61**
CD (p≤0.05)	**31.05**	**12.34**
Sub plot Nitrogen levels		
N_0 (0 kg ha^{-1})	350.25	140.104
N_1 (60 kg ha^{-1})	430.22	172.08
N_2 (120 kg ha^{-1})	506.44	202.57
N_3 (180 kg ha^{-1})	546.07	218.42
SEm±	**13.53**	**5.41**
CD (p≤0.05)	**39.75**	**15.90**

A perusal of the data given in Table 1 showed that nitrogen levels had a significant effect on leaf: stem ratio. Among the various nitrogen levels, N_3 (180 kg N ha^{-1}) recorded significantly higher leaf stem ratios at 30 DAS (1.23 cm), 60 DAS (0.86 cm), and harvest (0.48 cm) compared to N_1 (60 kg N ha^{-1}) and N_0 (Control). However, it was at par with N_2 (120 kg N ha^{-1}). The lowest leaf: stem ratio was observed in N_0 (Control). It was mainly due to the rapid expansion of dark green foliage, which could intercept and utilize the incident solar energy in the production of photosynthates, resulting in higher meristematic activity and leaf: stem ratio of fodder maize. Manjanagouda *et al.* (2017) and Somashekhar (2018) reported that an increase in nitrogen levels increased the leaf: stem ratio. The data regarding the number of leaves plant^{-1} is given in Table 1 which indicates that the number of leaves plant^{-1} in fodder maize was significantly influenced by nitrogen levels. Among N levels, N_3 (180 kg N ha^{-1}) resulted in a higher number of leaves, however, it was at par with N_2 (120 kg ha^{-1}). The N_0 (Control) recorded the lowest number of leaves. Mahdi *et al.* (2012) also observed a significant increase in the leaf number plant^{-1} with an increase in nitrogen levels. An increase in the number of green leaves might be attributed to the availability of sufficient nitrogen at all stages of growth. Plant height increased the number of nodes plant^{-1}, resulting in more number of leaves plant^{-1}. Again, nitrogen helped in the rapid growth and development by helping in photosynthesis and various biochemical processes which respond to growth (Iqbal *et al.* 2016).

The data in Table 1 showed that sowing dates had a significant impact on dry matter accumulation. Among nitrogen levels, N_3 (180 kg N ha^{-1}) recorded the highest dry matter accumulation at 30 DAS (36.87 q ha^{-1}), 60 DAS (107.57 q ha^{-1}) and at harvest (157.21 q ha^{-1}), which was at par with N_2 (120 kg N ha^{-1}). However, N_0 (Control) recorded the lowest dry matter accumulation. The increase in dry matter production at higher nitrogen levels might be due to enhanced metabolic activity as well as increased cell growth and elongation. An increased dose of Nitrogen enhanced the photosynthetic surface area (LAI), resulting in higher dry matter accumulation. The findings are in accordance with the findings revealed by Puri and Tiwana (2008), Ali et al. (2012), and Mahdi *et al.* (2012).

Data presented in Table 2 indicated that green fodder yield was significantly influenced both by nitrogen levels and among nitrogen levels N_3 (180 kg N ha^{-1}) recorded maximum green fodder yield (546.07 q ha $^{-1}$) whereas N_0 (Control) recorded significantly lowest green fodder yield (350.25 q ha^{-1}). However, N_3 (180 kg N ha^{-1}) was found to be statistically at par with N_2 (120 kg N ha^{-1}). The highest green fodder yield with the N_3 level is due to efficient growth and yield attributes such as plant height, leaf area, number of leaves per plant and dry matter production. Nitrogen is an essential component of plant tissue and is associated with cell division and elongation. Therefore its positive impact on growth parameters resulted in better yield. These results are in accordance with the findings of Panwar *et al.* (2020), who observed that increasing nitrogen levels significantly increases green fodder yield.

The data regarding dry fodder yield is presented in Table 2 which indicates that dry yield was significantly influenced by nitrogen levels. Among nitrogen levels, N_3 (180 kg N ha^{-1}) recorded the highest dry fodder yield (218.42 q ha^{-1}), whereas N_0 (Control) recorded the lowest. However, N_3 (180 kg N ha^{-1}) was statistically at par with N_2 (120 kg N ha^{-1}). Since nitrogen is an important component of plant tissue and plays an essential role in cell division and elongation, its beneficial effect on growth characteristics such as plant height, leaf area index, and stem diameter might have contributed to increased yield. Eltelib *et al.* (2006) also reported similar results. The increase in fodder yield was evidently due to the cumulative effect of increased growth parameters, which ultimately resulted in increased green and dry fodder yields. Budakli *et al.* (2010), Aslam *et al.* (2011), Patel *et al.* (2017), and Meena *et al.* (2021) also reported similar findings.

Quality parameters

The data given in Table 3 showed that nitrogen levels had a significant effect on the crude protein content of fodder maize. Among Nitrogen levels, N_3 (180 kg N ha^{-1}) recorded the highest protein content, whereas N_0 (Control) recorded the lowest. However, N_3 (180 kg N ha^{-1}) was statistically at par with N_2 (120 kg N ha^{-1}). Ullah *et al.* (2018), Mahdi *et al.* (2012), and Eltelib *et al.* (2006) also confirmed that increasing nitrogen levels increases crude protein content. This might be due to the fact that plants have 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).

A perusal of the data given in Table 3 revealed that neutral detergent fiber and acid detergent fiber differed significantly with respect to nitrogen levels. Among nitrogen levels, both neutral detergent fiber and acid detergent fiber were seen be decreasing as nitrogen levels increased, while N0 (Control) recorded the highest neutral detergent fiber (70.60%) and acid detergent fiber (48.01%) than other nitrogen levels. While the lowest neutral detergent fiber (63.12%) and acid detergent fiber (40.28%) were recorded in N_3 (180 kg N ha^{-1}), which was at par with N_2 (120 kg N ha^{-1}). The results are in accordance with the findings reported by Almodares *et al.* (2009), who observed that fiber content decreased with an increase in nitrogen levels.

The data in Table 3 revealed sowing dates had a significant impact on ash content. Among nitrogen levels, the highest ash content (9.16%) was recorded in N_3 (180 kg N ha^{-1}), which was statistically at par with N_2 (120 kg N ha^{-1}), and is attributed to the greater dry matter content, which improved mineral matter. However, the lowest ash content (7.69%) was recorded in N_0 (Control). Saruhan and Sireli (2005) also found that increasing the nitrogen dose increased the ash content of fodder maize.

Table 3: Effect of sowing dates and nitrogen levels on Quality parameters of Shalimar Fodder Maize -1

Treatments	Crude protein (%)	Ash content (%)	Neutral detergent fiber (NDF %)	Acid detergent fiber (ADF %)
Main plot Dates of sowing				
S_1 (15thApril)	9.23	8.73	69.23	46.98
S_2 (15th May)	9.04	8.60	67.67	44.77
S_3 (15th June)	8.97	8.43	65.15	41.57
S_4 (15th July)	8.90	8.31	62.61	39.98
SEm±	**0.17**	**0.16**	**0.23**	**0.26**
CD ($p \leq 0.05$)	**NS**	**NS**	**0.82**	**0.92**
Sub plot Nitrogen levels				
N_0 (0 kg ha^{-1})	8.39	7.69	70.60	48.01
N_1 (60 kg ha^{-1})	8.83	8.42	66.50	44.77

N_2 (120 kg ha^{-1})	9.26	8.80	64.45	41.57
N_3 (180 kg ha^{-1})	9.67	9.16	63.12	40.28
SEm±	**0.14**	**0.12**	**0.67**	**0.63**
CD (p≤0.05)	**0.42**	**0.37**	**1.99**	**1.86**

Relative economics

The data in Table 4 showed that sowing dates and nitrogen levels had a significant effect on gross returns, net returns, and benefit: cost ratio. The relative economics in terms of gross returns, net returns, and benefit: cost ratio with respect to green fodder yield was worked out for various treatment combinations. The data revealed that fodder maize sown on the 15th April (S_1) date of sowing and Nitrogen level N_3 (180 kg N ha^{-1}) recorded the highest gross returns (₹ 193967), net returns (₹ 143842), and benefit: cost ratio (2.87) followed by 15th May sowing with N_2 (120 kg N ha^{-1}). The lowest gross returns, net returns and benefit: cost ratio were recorded by fodder maize on 15th June (S_1) sowing with Control (N_0). This could be due to higher green fodder yield in these treatment combinations than in others. The findings are in agreement with Patel *et al.* (2017).

Table 4: Relative economics of Shalimar Fodder Maize-1 under varied sowing dates and nitrogen levels

Treatments	Cost of Cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
S_1N_0	47690	116100	68410	1.43
S_1N_1	48299	144400	96101	1.99
S_1N_2	49212	169933.3	120721.3	2.45
S_1N_3	50125	193966.7	143841.7	2.87
S_2N_0	47690	112100	64410	1.35
S_2N_1	48299	137733.3	89434.33	1.85
S_2N_2	49212	159933.3	110721.3	2.25
S_2N_3	50125	177300	127175	2.54
S_3N_0	47690	102100	54410	1.14
S_3N_1	48299	124400	76101	1.58
S_3N_2	49212	145933.3	96721.33	1.97
S_3N_3	50125	157300	107175	2.14
S_4N_0	47690	90010	42320	0.89
S_4N_1	48299	109733.3	61434.33	1.27
S_4N_2	49212	131933.3	82721.33	1.68
S_4N_3	50125	126723.3	76598.33	1.53

CONCLUSION

In conclusion, the results of the investigation indicated that fodder maize sown on 15th April (S_1) and nitrogen level N_2 (120 kg ha^{-1}) produced higher yield attributes, yield, quality and economics of fodder maize however, it was statistically at par with sowing done on 15th April

(S_1) and nitrogen level N_2 (120 kg ha^{-1}). Highest gross returns, net returns and benefit: cost ratio were recorded with the 15th April (S_1) sowing date and with a combination of nitrogen level N_3 (180 kg N ha^{-1}) followed by N_2 (120 kg ha^{-1}).

Based on the above studies we concluded that under Kashmir valley conditions, sowing of fodder maize should be carried around 15th April (S_1) with nitrogen level N_2 (120 kg ha^{-1}).

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