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Effect of Date of Sowing and Varieties on Performance of Summer Fodder Pearlmillet (*Pennisetum glaucum* L.) under North Gujarat Condition

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***Abstract*:** Field experiment was conducted on loamy sand soil at S. D. Agricultural University, Sardarkrushinagar, Gujarat during summer season of 2021. The experiment was laid out in split plot design with fifteen treatment combinations replicated thrice comprised of three dates of sowing in main plots *viz.* 25th February, 12th March and 27th March and five varieties in sub plots *viz.* Gujarat Fodder *Bajra* 4, Gujarat Fodder *Bajra* 1, BAIF *Bajra* 1, TSFB 15-8 and Moti *Bajra.* Crop sown on 12th March recorded significantly higher total green fodder and dry fodder yield *i.e*., 589.8 and 139.2 q/ha, respectively. The 25th February sown crop was statistically at par with the crop sown on 12th March. Among the varieties, Gujarat Fodder Bajra 4 recorded significantly higher total green fodder yield (625.6 q/ha) and dry fodder yield (148.5 q/ha). TSFB 15-8 was statistically at par with Gujarat Fodder *Bajra* 4. The maximum B: C ratio *i.e.*, 2.25 was obtained under 12th March sown crop as compared to other dates of sowing. In case of varieties, maximum B: C ratio *i.e.* 2.39 was obtained in Gujarat Fodder *Bajra* 4.

***Keywords*:** Date of sowing, Economics, Pearlmillet, Quality, Varieties, Yield

Livestock is becoming agriculture's most economically important sub sector and contributes 25% to the total agricultural income. One of the major reasons for low animal productivity in India is the shortage as well as poor quality of fodder. In Gujarat, total animal population is about 18.4 million and their optimum fodder requirement is 42.2 million tonnes, whereas, the availability is of only 20.0 million tonnes of forage during normal year (Pareek et al 2015). Cereals have major role to play in the fodder supply. Four major cereals *viz.* maize, barley, sorghum and pearlmillet account for approximately 44% of total cereals fodder production. Pearlmillet (*Pennisetum glaucum* L.) is an annual crop belongs to the family Poaceae (Gramineae), which is grown for food as well as fodder. It is a fast growing and short duration crop which has high biomass production potential. Pearlmillet as a fodder crop has some additional advantages over sorghum and maize because of high crude protein content (9.9 to 14%) and absence of hydrocyanic acid which makes feeding of green fodder of any crop stage safer to the cattle. It is nutritious, palatable and can be fed as green, dry or conserved in the form of silage or hay.

Date of sowing is an important non-monetary input affecting the fodder yield of summer pearlmillet. The weather parameters like rainfall, temperature and day length greatly influence the crop yield through their effect on phenological development of the crop. Late sowing coincides with high temperature, high wind velocity and early monsoon showers at reproductive stage adversely affect crop growth and yield, whereas, early sowing faces problems of low temperature during the initial stage of growth in North Gujarat. Moreover, late sowing does not leave enough time to prepare the land for *kharif* crop which resulted in delayed sowing of *kharif* crops. The sowing date is reported to have a significant impact on crop growth and development (Abd El-Lattief 2011), which is then reflected in yield and quality. Accurate decision-making with regard to the sowing date is not only important to achieve the higher crop yield and better quality fodder but also for minimizing the risk of crop failure. Santos et al (2017) reported that timely sowing decreases overall farming costs by eliminating labour and re-sowing costs. Therefore, it was of prime importance to find out the optimum date of sowing of fodder pearlmillet.

Feed shortage is a major challenge in livestock production enhancement. There are many options to cover the gap between forage demand and supply, one of them is adoption of high yielding crop varieties (Hassan et al 2014, Babiker et al 2015). Adoption of high yielding short duration varieties play an important role in the maximization of pearlmillet productivity. Screening of varieties which are appropriate to that particular climatic condition can help in boosting the production of pearlmillet. The identification of suitable variety to enhance productivity and quality is crucial to mitigate the present shortage of fodder requirement in summer season. Keeping in mind these facts, experiment was planned and conducted.

MATERIAL AND METHODS

Field experiment was conducted during summer season of 2021 at S.D. Agricultural University, Sardarkrushinagar. The standard week-wise meteorological data for the period of this investigation recorded at the Agricultural Meteorological Observatory (Fig. 1). The soil of the experimental field was loamy sand in texture with slightly alkaline in reaction. The details of the soil physical and chemical properties of the experimental plot are given in the Table 1. The experiment was laid out in split plot design with three replications. There were fifteen treatment combinations comprised of three dates of sowing in main plots *viz.* 25th February (D_1), 12th March (D_2) and 27th March (D_3) and five varieties in sub plots *viz.* Gujarat Fodder *Bajra* 4 (V_1), Gujarat Fodder *Bajra* 1 (V_2), BAIF *Bajra* 1 (V_3), TSFB 15-8 (V_4) and Moti *Bajra* (V_5). The crop was sown using recommended agronomic practices.

The biometric observations were recorded from randomly selected five plants in each net plot. Actual numbers of plants per metre row length were counted before harvesting of each cut without considering the tillers per plants. The plant height was measured from base to the tip of the plant at each cut. The number of leaves per plant was recorded at each cut. The average of five plants was calculated and presented as number of leaves/plant. The length of five leaves was measured from the base of the stem to the tip of the leaf to calculate average leaf length (cm). Similarly, the width of five leaves of the plant measured from the middle of the leaf to calculate the average leaf width (cm). Leaf: stem ratio was calculated during each cut at the time of harvest. The leaves were separated from the stem and fresh weight of both leaves and stem were recorded separately and leaf stem ratio is computed by dividing the leaves weight by stem weight and expressed in ratio. Average stem girth was calculated using the girth of five stem of the plant measured from the base, middle and tip of the stem. Two cuts were taken for green forage. The first cut was taken at 55 DAS, whereas, the second cut was taken 35 days after first cut (90 DAS). The ring area of each plot was first harvested and removed. The plants from the net plot were harvested keeping 5 cm stubble height from ground level and the fresh weight of harvested produce was recorded for each treatment separately at each cut and converted into quintal per hectare. After calculating green forage yield, one kg of green plant sample was weighed randomly from each net plot and kept in a brown paper bag. Thereafter, samples were first sun-dried then oven dried at 65°C. After oven drying, the dry forage yield in quintal per hectare was calculated on the basis of dry weight of sample for each treatment at each cut.

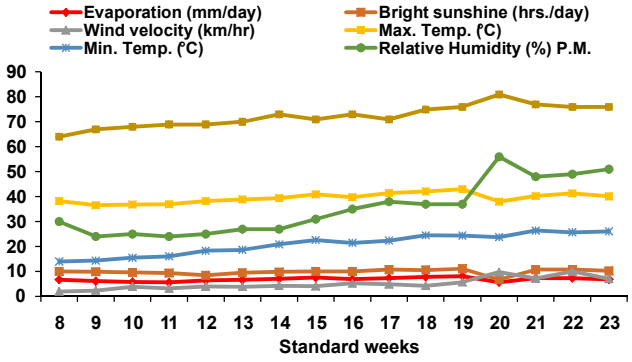

Fig. 1. Mean weekly weather parameters recorded during crop growth period of summer-2021

Total nitrogen content was determined by modified Kjeldahl method. Crude protein content of fodder was estimated by multiplying nitrogen percentage with 6.25 (Tsen and Martin 1971). The previously grinded and powdered samples were used to estimate the crude fibre (Mahadevan (1965). The residue left after ether extract was first boiled in 1.25 N H_2SO_4 followed by boiling in 1.25 N NaOH. The respective residue was washed with hot water, dried in oven and weighed. Thereafter, it was ashed in muffle furnace and per cent crude fiber was calculated using the formula given below.

$$\text{Crude fibre content (\%)} = \frac{\text{Weight of silica crucible with oven dry residues} - \text{Weight of silica crucible with ash}}{\text{Weight of oven dry sample}} \times 100$$

To evaluate the most effective and remunerative treatment, the relative economics of each treatment was worked out in terms of gross, net realization and benefit: cost ratio. The gross realization in term of ₹/ha was calculated from the income received from dry matter of each treatment with the prevailing market price. The cost of cultivation was worked out considering the cost of all the operations and inputs right from the preparation of land to harvesting of the crop. The net realization was worked out by deducting the total cost of cultivation from the gross realization per hectare for each treatment and recorded accordingly. The benefit: cost ratio (BCR) was calculated.

$$\text{Benefit: Cost Ratio} = \frac{\text{Gross realization (₹/ha)}}{\text{Total cost of cultivation (₹/ha)}}$$

Statistical analysis: Analysis and interpretation of data was done using MS excel programme.

RESULTS AND DISCUSSION

Growth and yield attributes: The plant height, number of leaves per plant, leaf length, leaf: stem ratio and stem girth

were influenced significantly by different dates of sowing (Table 2). Crop sown on 12th March (D_2) produced significantly higher plant height, number of leaves per plant, leaf length), leaf: stem ratio and stem girth at 1st and 2nd cut, and was at par with 25th February sowing. The leaf width of fodder pearlmillet recorded at 1st and 2nd cut was non-significant due to different dates of sowing. This might be due to the sowing of pearlmillet at appropriate time which provided favourable climatic conditions in terms of temperature, humidity and bright sunshine hour during crop growth period, that had resulted in more cell division and enlargement which ultimately leads to more growth of crop. The present findings are in accordance with earlier observations (Abd El-Lattief 2011, Reiad et al 2014, Chaudhary et al 2020). Pearlmillet varieties significantly influenced plant height, number of leaves per plant, leaf length, leaf: stem ratio and stem girth except leaf width. Gujarat Fodder *Bajra* 4 recorded significantly higher plant height, number of leaves per plant, leaf length, leaf: stem ratio and stem girth and was at par with TSFB 15-8. This might be due to difference in genetic constitution among the varieties (Manjanagouda 2015, Bramhaiah 2016, Chaudhary 2021).

Fodder yield: Green fodder and dry fodder yields were influenced significantly by different dates of sowing (Table 3).

Table 1. Physico-chemical properties of the experimental soil

Properties	Soil depth (0-15 cm)	Methods of analysis
Mechanical composition		
Sand (%)	83.50	International pipette method (Piper 1966)
Silt (%)	7.55	
Clay (%)	7.10	
Textural classes	Loamy sand	
Chemical parameters		
Soil pH (1:2.5, Soil: Water ratio)	7.60	Potentiometric method (Jackson 1973)
Electrical conductivity (dS/m) 1:2.5, Soil: Water ratio at 25°C)	0.17	Schofield method (Jackson 1973)
Organic carbon (%)	0.16	Walkley and Black's rapid titration method (Walkley and Black 1934)
Available N (kg/ha)	160.20	Alkaline potassium permanganate method (Subbiah and Asijia 1956)
Available P_2O_5 (kg/ha)	32.47	Olsen's method (Olsen et al 1954)
Available K_2O (kg/ha)	282.00	Flame photometric method (Jackson 1973)

Table 2. Effect of date of sowing and varieties on growth of fodder pearlmillet

Treatment	Plant height (cm)		No. of leaves/plant		Leaf length (cm)		Leaf width (cm)		L:S ratio		Stem girth (mm)	
	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Main plot: Date of sowing (D)												
D_1: 25th February	166.4	145.2	9.29	7.90	65.01	60.92	1.86	1.76	0.49	0.45	30.49	28.51
D_2: 12th March	181.5	158.0	9.65	8.26	67.74	64.18	1.88	1.79	0.51	0.47	31.82	29.84
D_3: 27th March	146.9	124.4	8.57	7.13	59.21	55.85	1.81	1.72	0.44	0.40	28.24	26.12
CD (p-0.05)	15.57	14.16	0.81	0.64	5.99	6.08	NS	NS	0.05	0.04	2.66	2.60
Sub plot: Varieties (V)												
V_1: Gujarat Fodder *Bajra* 4	177.6	155.4	10.41	8.80	69.94	67.24	1.91	1.83	0.55	0.51	31.63	29.63
V_2: Gujarat Fodder *Bajra* 1	157.5	135.1	8.40	7.15	60.76	56.07	1.82	1.71	0.43	0.40	29.24	27.19
V_3: BAIF *Bajra* 1	154.9	133.3	7.63	6.56	57.64	52.36	1.79	1.68	0.39	0.35	28.65	26.55
V_4: TSFB 15-8	172.4	149.7	10.08	8.49	67.30	64.84	1.88	1.81	0.53	0.49	31.17	29.17
V_5: Moti *Bajra*	162.1	139.4	9.32	7.82	64.29	61.06	1.85	1.76	0.48	0.45	30.22	28.24
CD (p-0.05)	12.77	10.35	0.68	0.52	4.87	4.74	NS	NS	0.04	0.03	2.08	2.08
Interaction (D × V)												
CD (p-0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Crop sown on 12th March produced significantly higher total green fodder yield (589.8 q/ha) and dry fodder yield (139.2 q/ha). The 25th February sown crop was statistically at par with the crop sown on 12th March. The increase in yields with normal sowing might be attributed due to favourable effect on growth attributes *viz*. plant height, number of leaves per plant, leaf length, leaf: stem ratio and stem girth. This might have ultimately resulted in higher photosynthetic activities and also in production of more photosynthates(Chandrika et al 2012, Salama et al 2020, Kaur and Oberoi 2021).

Pearlmillet varieties significantly influenced the green fodder and dry fodder yield. Gujarat Fodder *Bajra* 4 recorded significantly higher total green fodder yield (625.6 q/ha) and dry fodder yield (148.5 q/ha). TSFB 15-8 was statistically at par with Gujarat Fodder *Bajra* 4 with respect to green and dry fodder yield. Fodder yield was significantly higher under Gujarat Fodder *Bajra* 4 which might be due to the superiority of the genotype to produce better growth characters like plant height, number of leaves per plant, leaf length, leaf: stem ratio and stem girth. In earlier studies also similar trend was

Table 3. Effect of date of sowing and varieties on yield of fodder pearlmillet

Treatment	Green fodder yield (q/ha)			Dry fodder yield (q/ha)		
	1st cut	2nd cut	Total	1st cut	2nd cut	Total
Main plot: Date of sowing (D)						
D_1: 25th February	314.0	244.5	558.5	76.66	55.06	131.7
D_2: 12th March	332.0	257.8	589.8	81.16	58.06	139.2
D_3: 27th March	290.2	216.3	506.5	70.72	48.70	119.4
CD (p-0.05)	30.04	24.48	47.92	7.30	5.46	11.19
Sub plot: Varieties (V)						
V_1: Gujarat Fodder *Bajra* 4	347.1	278.5	625.6	85.80	62.66	148.5
V_2: Gujarat Fodder *Bajra* 1	296.1	217.0	513.1	71.87	49.48	121.4
V_3: BAIF *Bajra* 1	273.6	198.1	471.7	66.21	45.15	111.4
V_4: TSFB 15-8	329.0	263.5	592.5	80.58	58.77	139.4
V_5: Moti *Bajra*	314.5	240.5	555.0	76.43	53.63	130.1
CD (p-0.05)	28.28	18.76	38.88	7.02	4.18	9.34
Interaction (D × V)						
CD (p-0.05)	NS	NS	NS	NS	NS	NS

Table 4. Effect of date of sowing and varieties on quality of fodder pearlmillet

Treatment	Crude protein content (%)		Crude fibre content (%)	
	1st cut	2nd cut	1st cut	2nd cut
Main plot: Date of sowing (D)				
D_1: 25th February	7.85	7.62	27.33	23.30
D_2: 12th March	8.00	7.78	27.61	23.47
D_3: 27th March	7.73	7.51	26.98	23.08
CD (p-0.05)	NS	NS	NS	NS
Sub plot: Varieties (V)				
V_1: Gujarat Fodder *Bajra* 4	8.19	7.98	28.57	24.23
V_2: Gujarat Fodder *Bajra* 1	7.69	7.47	26.39	22.32
V_3: BAIF *Bajra* 1	7.59	7.37	26.24	22.16
V_4: TSFB 15-8	7.99	7.77	28.02	24.01
V_5: Moti *Bajra*	7.84	7.61	27.31	23.69
C. D. at 5%	NS	NS	NS	NS
Interaction (D × V)				
CD (p-0.05)	NS	NS	NS	NS

Table 5. Correlation and regression equations for various dependent and independent parameters of fodder pearlmillet as influenced by date of sowing and varieties

Independent variable (x)	Dependent variable (y)	Correlation coefficient (r)	Regression equation	R^2
First cut				
Plant height (cm)	Green fodder yield (q/ha)	0.873**	y =45.20+1.62x	0.763
No. of leaves/plant		0.958**	y = 67.68+26.65x	0.917
Leaf length (cm)		0.976**	y = -32.77+5.39x	0.953
Leaf width (cm)		0.970**	y = -722.33+559.33x	0.942
Stem girth (mm)		0.924**	y = -157.74+15.56x	0.854
Green fodder yield (q/ha)	Dry fodder yield (q/ha)	0.999**	y = -4.85+0.26x	0.998
Second cut				
Plant height (cm)	Green fodder yield (q/ha)	0.859**	y =-13.62+1.78x	0.737
No. of leaves/plant		0.996**	y = -36.90+35.60x	0.992
Leaf length (cm)		0.995**	y = 76.59+5.24x	0.990
Leaf width (cm)		0.993**	y = -714.20+542.78x	0.987
Stem girth (mm)		0.922**	y = -219.80+16.31x	0.850
Green fodder yield (q/ha)	Dry fodder yield (q/ha)	0.998**	y = 2.16+0.22x	0.997

** = Significant at 1%
The variable x refers to the independent parameters listed in the column, variable y refers to the dependent parameters listed in the column

Table 6. Effect of date of sowing and varieties on economics of fodder pearlmillet

Treatment	Gross returns (₹/ha)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	BCR
Main plot: Date of sowing (D)				
D_1: 25th February	111700	52384	59316	2.13
D_2: 12th March	117960	52384	65576	2.25
D_3: 27th March	101300	52384	48916	1.93
CD (p-0.05)	-	-	-	-
Sub plot: Varieties (V)				
V_1: Gujarat Fodder *Bajra* 4	125120	52384	72736	2.39
V_2: Gujarat Fodder *Bajra* 1	102620	52384	50236	1.96
V_3: BAIF *Bajra* 1	94340	52384	41956	1.80
V_4: TSFB 15-8	118500	52384	66116	2.26
V_5: Moti *Bajra*	111000	52384	58616	2.12
CD (p-0.05)	-	-	-	-
Interaction (D × V)				
CD (p-0.05)	-	-	-	-

observed (Shroff and Patel 2017, Kaur and Goyal 2019, Chaudhary 2021).

Interaction effect between date of sowing and varieties: The interaction between date of sowing and varieties was non-significant for growth parameters, green and dry fodder yields as well as quality parameters.

Quality parameters: The crude protein content at 1st as well as 2nd cut of fodder pearlmillet crop did not differ significantly due to different date of sowing and varieties (Table 4). However, 12th March sown crop and Gujarat Fodder *Bajra* 4 variety had numerically high crude protein and crude fibre content values.

Correlation and regression analysis: There was significant and positive relationship found between plant height, number of leaves/plant, leaf length, leaf width, stem girth with the green fodder yield of fodder pearlmillet during 1st cut and 2nd cut, as evident from correlation coefficient (r) analysis (Table 5). This indicates that the enhancement in all the independent variable will increase the green fodder yield (dependent variable). There was significant positive relationship between green fodder yield and dry fodder yield indicating direct positive relationship between both parameters. Regression equations also revealed that increase in plant height by 1 cm, 1 leaf/plant, 1 cm leaf length, 1 cm leaf width, 1 mm stem girth shall increase the green

fodder yield of 1st cut by 1.62 q/ha, 26.65 q/ha, 5.39 q/ha, 559.33 q/ha and 15.56 q/ha, respectively. Similarly, the increase in plant height by 1 cm, 1 leaf/plant, 1 cm leaf length, 1 cm leaf width, 1 mm stems girth shall increase the green fodder yield of 2nd cut by 1.78 q/ha, 35.60 q/ha, 5.24 q/ha, 542.78 q/ha and 16.31 q/ha, respectively. Increase in green fodder yield by 1 q/ha in 1st and 2nd cut shall increase the dry fodder yield of 0.26 and 0.22 q/ha, respectively.

Economics: Crop sown on 12th March gave the highest gross returns (₹ 117960/ha), net returns (₹ 65576/ha) with maximum B: C ratio (2.25) as compared to other dates of sowing. In varieties, Gujarat Fodder *Bajra* 4 recorded the highest gross returns (₹ 125120/ha), net returns (₹ 72736/ha) with maximum B: C ratio (2.39) followed by TSFB 15-8. Among the pearlmillet varieties and date of sowing, Gujarat Fodder *Bajra* 4 and 12th March, respectively adjudged best on the basis of economics.

CONCLUSIONS

The fodder pearlmillet variety Gujarat Fodder *Bajra* 4 or TSFB 15-8 should be sown on 25th February or 12th March to obtain higher fodder yield under North Gujarat condition.

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