Agronomic Evaluation of Fodder Sorghum Varieties under Different Dates of Sowing

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Authors’ contributions

This work was carried out in collaboration among all authors. Author KS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript under the guidance of authors TP, DS and PL managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field study conducted during the summer season of 2018 at S.V. Agricultural College, Tirupati, Andhra Pradesh, to evaluate the sowing time and varieties on growth, yield and quality of fodder sorghum. The results revealed that plant height, dry matter production, leaf area, stem diameter, leaf stem ratio significantly decreased with delay in sowing from I FN of January to II FN of February at all stages of plant growth. Significantly higher crude protein and ash contents were observed with the crop sown during I fortnight of January. Late sowing of the crop during II fortnight of February recorded higher crude fibre. Among various varieties tested, higher growth parameters, green and dry fodder yields were recorded with CSV 32 F than rest of varieties. CSV 32 F has recorded highest crude protein and ash content, while the higher crude fibre content was recorded with CSV 21 F. The highest gross returns, net returns and benefit-cost ratio were obtained when the crop is sown during I FN of January which was significantly superior to other times of sowing. Among tested varieties, CSV 32 F variety recorded significantly higher returns.
Keywords: Summer; sowing time; varieties.

1. INTRODUCTION

The success of dairy largely depends on the availability of forages since almost 60-65% investment is accounted for these requirements. To harness the fruits of white revolution, emphasis on research relating to the crop improvement and management of forages is indeed very critical. Dairy has become one of the important components of farming systems in Chittoor district of Southern Agro Climatic Zone of Andhra Pradesh and it is widely known as “Andhra’s Anand” because it ranks first in milk production in entire state. Green fodder scarcity is the most common problem during summer months i.e. from March to April.

Sorghum is an important widely grown forage crop for dairy animals. It is fast-growing, quick in recovery after cutting, palatable, nutritious and utilized as silage and hay besides fresh feeding. Sorghum crop is adaptive to vast environmental conditions in India. It can sustain high temperature and less moisture conditions [1] and provides green fodder to the animals for a considerable length of period. Government of Andhra Pradesh is also encouraging the farming community to grow fodder sorghum by giving subsidy, hence farmers of Chittoor district are habituated for cultivation of fodder sorghum [2].

Seasonal variation in production of fodder results in large gap between demand and supply of green fodder during crucial periods of the year such as summer. Development of location-specific agro techniques and identification of good quality genotypes of sorghum offer an excellent opportunity to provide good quality fodder for better nutrition to bovine population.

Among agronomic manipulations, sowing time and suitable cultivars are considered to be important for increased production potentials of fodder sorghum. The sowing time of the sorghum affects the fodder supply to a considerable extent and hence, proper sequencing of the sowing time should be done to achieve maximum fodder yield along with maintaining the regular supply of the green fodder.

The identification of suitable genotype for enhanced productivity and quality during summer is crucial to mitigate the present shortage of fodder requirement in summer season. Keeping in view, the above facts the present experiment was taken up optimize the sowing time with suitable cultivar.

2. MATERIALS AND METHODS

The field experiment was conducted at S.V. Agricultural College Dryland farm, Tirupati, Acharya N. G. Ranga Agricultural University, Andhra Pradesh, India during 2018. The experimental field was sandy loam in texture which is low in organic carbon (0.45%).

The soil is neutral in reaction (pH 7.1), low in available N (175 kg ha\(^{-1}\)) and medium in available phosphorus (28 kg ha\(^{-1}\)) and potassium (204 kg ha\(^{-1}\)). Total rainfall received during the crop growth period was 127.6 mm in 6 rainy days. The experiment was laid out in a split plot design with three replications. The main treatments consisted of four times of sowings viz., I FN of January, II FN of January, I FN of February and II FN of February. The sub treatments consisted of three fodder sorghum varieties viz., CSV 21 F, CSV 30 F and CSV 32 F.

A uniform recommended dose of 80-40-30 kg N, P\(_2\)O\(_5\) and K\(_2\)O ha\(^{-1}\) was applied to fodder sorghum. The nutrients were applied in the form of urea, single super phosphate and muriate of potash. One light irrigation was given 5 days after sowing for better establishment of seedlings and thereafter field was irrigated at 10 days intervals during the crop growth period. All growth parameters recorded from five randomly tagged plants at different intervals viz., 20, 40, 60 DAS and at harvest the crop was harvested for green fodder purpose at 50 percent flowering in all the varieties. After harvesting, the crop was sun-dried in the same plot until the constant weight was observed for dry fodder yield. The proximate analysis for crude protein, crude fat, crude fibre, total ash in fodder sorghum was determined by standard methods [3]. Economics worked out based on the prevailing prices of inputs and outputs in the local market.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height

Irrespective of the adopted time of sowing and varieties tested, the plant height of fodder...
sorghum was tended to increase progressively with the advance in age of the crop (Table 1). The crop sown during I FN of January and II FN of January recorded higher plant height at 20 DAS and 40 DAS compared to the crop sown at later dates i.e I FN of February and II FN of February.

The lowest values were recorded with the crop sown during II FN of February. The trend was changed during the later dates of sampling at 60 DAS and at harvest. Early sowing of the crop during I FN of January has recorded maximum plant height than the crop sown at later dates which might be due to exposure of the crop to favourable climatic conditions that prevailed during the crop growth period and became instrumental in boosting up the growth. The present findings corroborate with that of Deshmukh et al. [4], Girase et al. [5].

Among different fodder sorghum varieties tested, CSV 32 F has recorded the maximum plant height during all sampling dates. The lowest plant height was observed in CSV 21 F during the corresponding dates of sampling dates. Significant differences observed in plant height, among different varieties might be due to the difference in genetic characters. These results align with the findings of Satpal et al. [1], Shinde et al. [6].

3.2 Dry Matter Production

The data on dry matter production as influenced by the times of sowing and varieties presented in Table 1 shows that variation in dry matter production was significant during all the dates of sampling due to adopted times of sowing. The crop sown early during I FN of January accumulated larger dry matter than the crop sown at later dates. The dry matter production was progressively and significantly reduced with the extended date of sowing from I FN of January to II FN of February and least values registered when sowing of the crop was delayed to II FN of February. This trend was observed all through the sampling dates from 20 DAS to until harvest at 20 days interval.

Plant height, leaf area and leaf stem ratio are the major factors influencing the dry matter production. The highest dry matter production was obtained when the crop was sown during I FN of January. It might be attributed to the maximum length of the growing period available for early sowing which results in better vegetative growth with maximum dry matter accumulation. Enhanced dry matter production under varied times of sowing as evident in this investigation corroborates with the findings of Patel et al. [7].

Among the fodder sorghum varieties tried, the highest dry matter production (1344 kg ha⁻¹) was recorded by CSV 32 F which was superior over rest of varieties. This trend was observed all through the sampling dates from 20 DAS to until harvest at 20 days interval. Higher leaf area resulted in increased photosynthates, which is further contributing to higher dry matter production. It might be due to genetic potential of those particular varieties and contributing factors of dry matter production. These findings were by the results obtained by Singh et al. [8], Mishra et al. [9].

3.3 Leaf Area

The data on leaf area as influenced by the times of sowing and variety presented in Table 2 reveals that variation in leaf area of fodder sorghum was significant with adopted times of sowing. The crop sown during I FN of January recorded significantly highest leaf area than the crop sown later on other dates at all sampling dates. The lowest value of leaf area was observed with II FN of February. At the harvest, the performance of the crop sown early during I FN of January was outstanding which produced maximum leaf area followed by the crop sown during II FN of January.

Crop sown during I FN of January produced maximum leaf area which may be attributed to more number of leaves of larger size due to exposure of crop to optimum weather conditions. Lower leaf area with II FN of February might be due to prevalence of higher temperatures during crop growth which has restrained the cell elongation and expansion owing to accelerated transpirative demand resulted in quick desiccation of leaves and unbalanced ratio of photosynthesis and respiration eventually reduced the number of leaves. The variation in leaf area due to different times of sowing was also observed by Mishra et al. [9].

Maximum and minimum leaf area was observed with CSV 32 F and CSV 21 F respectively at all the stages of crop growth. This might be due to difference in genetic constitution among the varieties. These results were in conformity with the findings of Mishra et al. [9], Srivastava et al. [10], Satpal et al. [1].
The maximum leaf stem ratio was recorded with the crop during I FN of January which was significantly superior to the crop sown during other times of sowing. The leaf stem ratio was progressively and significantly reduced with the extended date of sowing from I FN of January to II FN of February. Lowest values of leaf stem ratio were registered when sowing of the crop was delayed to II FN of February. The early sown crop recorded the highest leaf stem ratio due to higher stem weight and lower leaf weight compared to that at other times of sowing.

Table 1. Effect of time of sowing and varieties on plant height and dry matter production

| Treatments | Plant height (cm) | Dry matter production (kg ha⁻¹) |
|------------|------------------|-------------------------------|
|            | 20 DAS | 40 DAS | 60 DAS | Harvest | 20 DAS | 40 DAS | 60 DAS | Harvest |
| **Times of sowing** |       |        |        |         |        |        |        |         |
| I FN of January | 176.9  | 1443.5 | 2092.5 | 2187.2 | 1.22  | 0.96  | 0.61  | 0.36    |
| II FN of January | 171.4  | 1268.3 | 1692.3 | 1816.6 | 1.04  | 0.89  | 0.56  | 0.32    |
| I FN of February | 165.5  | 1156.0 | 1397.2 | 1586.4 | 0.96  | 0.76  | 0.52  | 0.28    |
| II FN of February | 113.8  | 1019.0 | 1345.3 | 1452.7 | 0.84  | 0.62  | 0.47  | 0.25    |
| **SEm±** |       |        |        |         |        |        |        |         |
| CD ( P= 0.05) | 4.9    | 29.0   | 100.7  | 44.1    | 0.03  | 0.02  | 0.005 | 0.005   |

3.4 Leaf Stem Ratio

The maximum leaf stem ratio was recorded with the crop during I FN of January which was significantly superior to the crop sown during other times of sowing. The leaf stem ratio was progressively and significantly reduced with the extended date of sowing from I FN of January to II FN of February. Lowest values of leaf stem ratio were registered when sowing of the crop was delayed to II FN of February. The early sown crop recorded the highest leaf stem ratio due to higher stem weight and lower leaf weight compared to that at other times of sowing.

Fodder sorghum varieties differed significantly in leaf stem ratio during all dates of sampling from 20 DAS until harvest. The highest leaf stem ratio was recorded in CSV 32 F during the sampling dates. The lowest leaf stem ratio was observed in CSV 21 F. This might be due to the genetic variation among the varieties. The CSV 32 F variety has profuse growth with more number of leaves, leaf area and stem diameter which might have contributed to higher leaf stem ratio. These results are in line with the earlier findings as reported by Satpal et al. [1] and Shinde et al. [6].

3.5 Stem Diameter

The data on stem diameter was influenced by the times of sowing and varieties, however, interaction effect between them was non-significant (Table 3). The crop sown during I FN of January and II FN of January recorded highest stem diameter at 20 DAS and 60 DAS compared...
to the crop sown at other later dates during I FN of February and II FN of February. The trend was changed during the sampling date of 40 DAS. Early sowing of the crop during I FN of January recorded highest stem diameter than the crop sown later during II FN of January, I FN of February and II FN of February.

The lower stem diameter was recorded with II FN of February sown crop. It might be attributed that early sown crop might have explored the benefits of favourable climatic conditions in terms of temperature and other climatic parameters during various crop growth stages, which reflected into better growth.

Progressed stem diameter under varied times of sowing as evident in this investigation corroborates with the findings of Desai et al. [11] and Mishra et al. [9].

The highest stem diameter was recorded with CSV 32 F during all dates of samplings until harvest. The lowest stem diameter was observed with CSV 21 F. Differences in stem diameter of sorghum genotypes might be attributed to variations in their genetic constitutions. The present findings were in conformity with those of Akbari et al. [12] and Mishra et al. [9].

3.6 Quality Parameters

Crude protein is one of the prime parameter which indicates the part of organic matter present in the dry matter. The crude protein content was progressively decreased with extended times of sowing from I FN of January to II FN of February. This might be due to congenial weather conditions prevailed during the crop growth period which helped in higher growth and metabolism as supported by growth contributing characteristics and biomass production in turn resulted in increased protein content. The present findings were in conformity with those of Chandrika et al. [13], Patel et al. [7].

Among various varieties tested, CSV 32 F recorded the highest crude protein content and was significantly superior over rest of the varieties. The variety CSV 21 registered lowest crude protein content. It might be due to its genetic potential in rapid synthesis of carbohydrates and their conversion to protein and protoplasm leaving a relatively smaller portion for cell wall synthesis along with more dry matter production, which corroborate with the results of Meena et al. [14].

3.7 Crude Fibre Content

Crop sown during I FN of January recorded the minimum crude fibre content which was however comparable with II FN of January. The lowest crude fibre content recorded by the early sowing of the crop during I FN of January might be attributed to the uptake of nitrogen at higher rates by the crop under favourable weather conditions of temperature, relative humidity and low evaporation rates that resulted in more vegetative growth and higher crude protein which in turn decreased the fibre content in the fodder. Patel et al. [7] from their studies observed that lowest crude fibre content of fodder might be due to more vegetative growth of crop which is associated with higher uptake of nitrogen, the major constituent of amino acids and protein which in turn tone down the fibre constituents like pectin, cellulose and hemicelluloses.

Significantly the higher crude fibre content was noticed with CSV 21 F, which was on par with CSV 30 F, which in turn was on par with CSV 32 F. The lowest crude fibre content observed in CSV 32 F variety. Similar findings were reported by Meena et al. [13].

3.8 Ash Content

Ash content indicates the total minerals present in fodder, which is an inorganic matter of dry matter production. To meet the requirement of the mineral of cattle, the fodder should have higher ash content. The crop sown during I FN of January recorded significantly higher ash content compared to the crop sown on other later dates. The least ash content was noticed with crop sown during II FN of February which was however comparable with February I FN sowing.

Among the different varieties tested, the highest ash content was observed in CSV 32 F which was significantly superior over rest of the varieties. The lowest ash content was recorded by CSV 21 F.

The higher ash content in CSV 32 F variety of fodder sorghum sown during I FN of January might be attributed to the fact that higher dry matter production which improved mineral matter. Such reports were also given by Meena et al. [13].

3.9 Fodder Yield

The data on green and dry fodder yield presented in Table 4 indicated that crop sown
during I fortnight of January recorded the maximum green and dry fodder yield which was comparable with crop sown on II fortnight of January. Sowing of the crop at later dates recorded the lower green fodder yields.

The higher green fodder productivity with I fortnight of January sowing is attributed to the prevalence of maximum and minimum temperatures within the favorable limits of the crop. Reduction in the yield of green and dry fodders with late sown crop (II fortnight of February) may be attributed to less production of forage owing to exposure of the crop to higher temperatures of maximum and minimum at all growth stages elevated by 4.3 and 5.8°C respectively. Similar findings were reported from the studies of Deshmukh et al. (2009). CSV 32 F recorded significantly higher green and dry fodder owing to its superior performance of growth and yield parameters which might be due to its high genetic potential to higher resource conversion efficiency. Similar results were obtained by Satpal et al. [1].

3.10 Economics

The highest gross returns, net returns and benefit cost ratio were obtained when crop sown during I FN of January which was significantly superior to other times of sowing. Among tested varieties CSV 32 F variety recorded significantly higher returns whereas the lowest net returns and benefit-cost ratio were obtained from CSV 21 F variety.

| Treatments | Stem diameter (cm) | Quality parameters |
|------------|-------------------|--------------------|
|            | 20 DAS | 40 DAS | 60 DAS | Harvest | Crudeprotein | Crude fibre | Ash content |
| Times of sowing |        |        |        |         |              |            |             |
| I FN of January | 1.23  | 1.94  | 2.40  | 2.69   | 8.58              | 30.76        | 8.75        |
| II FN of January | 1.05  | 1.76  | 2.18  | 2.56   | 8.31              | 32.49        | 8.40        |
| I FN of February | 1.03  | 1.55  | 1.98  | 2.34   | 7.93              | 34.45        | 8.07        |
| II FN of February | 0.98  | 1.57  | 1.85  | 2.20   | 7.65              | 35.63        | 7.89        |
| SEm± | 0.03  | 0.04  | 0.46  | 0.04   | 0.05              | 0.52         | 0.07        |
| CD ( P= 0.05) | 0.10  | 0.12  | 0.16  | 0.12   | 0.16              | 1.79         | 0.24        |
| Varieties |        |        |        |         |              |            |             |
| CSV 21 F | 0.80  | 1.28  | 1.69  | 1.69   | 7.61              | 34.44        | 7.79        |
| CSV 30 F | 1.06  | 1.66  | 2.07  | 2.50   | 8.02              | 33.42        | 8.27        |
| CSV 32 F | 1.36  | 2.17  | 2.55  | 3.14   | 8.72              | 32.14        | 8.78        |
| SEm± | 0.02  | 0.04  | 0.03  | 0.05   | 0.04              | 0.45         | 0.06        |
| CD ( P= 0.05) | 0.05  | 0.12  | 0.10  | 0.14   | 0.11              | 1.36         | 0.18        |

| Treatments | Green fodder yield (t ha⁻¹) | Dry fodder yield (t ha⁻¹) | Gross returns (ha⁻¹) | Net returns (ha⁻¹) | B : C ratio |
|------------|-------------------------------|---------------------------|----------------------|-------------------|-------------|
| Times of sowing |                               |                           |                      |                   |             |
| I FN of January | 34.64                        | 13.87                     | 69284                | 34247             | 1.98        |
| II FN of January | 32.70                        | 13.07                     | 65406                | 30369             | 1.87        |
| I FN of February | 28.96                        | 11.60                     | 57930                | 22593             | 1.64        |
| II FN of February | 24.50                        | 9.80                      | 49005                | 13368             | 1.37        |
| SEm± | 0.93                          | 0.39                      | 1861                 | 1860              | 0.05        |
| CD ( P= 0.05) | 3.22                          | 1.35                      | 6440                 | 6440              | 0.18        |
| Varieties |                               |                           |                      |                   |             |
| CSV 21 F | 24.46                        | 9.79                      | 48929                | 14067             | 1.41        |
| CSV 30 F | 29.62                        | 11.94                     | 59698                | 24236             | 1.68        |
| CSV 32 F | 36.30                        | 14.52                     | 72591                | 37129             | 2.05        |
| SEm± | 0.65                          | 0.26                      | 1311                 | 1311              | 0.04        |
| CD ( P= 0.05) | 1.96                          | 0.79                      | 3930                 | 3930              | 0.11        |
It is fact that realization of higher gross returns was the result of higher yield. Remunerative economic returns (net returns and B:C ratio) play a key role, to convince the farmers for adoption of any refined version of agro-techniques. This might be owing to the better performance of that variety resulted in higher green fodder yield which was responsible for higher monetary returns. These results are in line with the earlier findings as reported by Satpal et al. [1], Mishra et al. [9].

4. CONCLUSION

The fodder sorghum sown during 1 FN of January resulted in the highest growth, yield and quality parameters which in turn resulted in more net returns and benefit-cost ratio. However, fodder sorghum sowing can also be extended upto II FN of January as the growth and performance of crop was not restrained to a measurable extent by the climatic factors. Among the fodder sorghum varieties tested, the variety CSV 32 F performed better than the other varieties owing to its genetic attributes with better resource conversion efficiency compared to rest of the varieties for higher yield.

The results in a nut shell revealed that higher green fodder yield of summer fodder sorghum as well as monetary returns could be realized with cultivation of the CSV 32 F fodder sorghum variety with sowing window of I FN of January in the present domain of study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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