Locational Variation in Chemical Composition and in Vitro Digestibility of Forage Sorghum

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The variability in nutritive parameters as affected by location was studied. Protein content varied from 5.10 to 6.77%, neutral detergent fiber from 59.24 to 69.21%, acid detergent fiber from 34.88 to 42.10%, in vitro dry matter digestibility from 52.07 to 61.93%, and tannin content from 4.65 to 21.48 mg/g at four locations. The dry matter yield and stem girth were highest at Hissar but leaf stem ratio was lowest. The highest number of leaves per running meter was observed at Delhi followed by Hissar, Amravati, and Parbhani. The tannin, ADF, and NDF contents of the genotypes were significantly and positively correlated with stem girth and number of leaves per running meter. There was a significant negative correlation between in vitro dry matter digestibility and stem girth of the genotypes.

Recently Wilson and Ford (1971) and Deinum and Dirven (1972) have reported a marked influence of temperature and environment on the quality of forage species. Under the All India Co-ordinated Project on Sorghum, the same genotypes are tested at different locations throughout India. Although scheduled agronomic practices are followed, a wide variation in the forage dry matter yield is observed. Locational differences have been reported on the quality aspects of grain sorghum (Deosthale and Mohan, 1970), but no report is available about the forage sorghum. It was thought interesting to find out how the nutritive parameters of forage sorghum are affected by location and hence the present work was undertaken.

MATERIALS AND METHODS

Eight promising varieties of forage sorghum were evaluated for their nutritive value under varied agro-climatic conditions prevailing at Amravati, Delhi, Hissar, and Parbhani. Plantings were made in the months of June and July except for Parbhani and Amravati where the sowing could not be done in time due to delayed rains. A randomized block design with four replicates was used at all the locations. The plot size was 10 m^2. One-hundred kilograms of N per ha in the form of calcium ammonium nitrate was used as a basal dose at all the locations. The samples were harvested at 50% flowering stage and dried in an oven at 60°. After drying, the samples were ground through a micro-Wiley mill having a screen of 2 mm. The structural components neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined by the Goering and Van Soest method (1970) through the use of appropriate detergent solutions. Protein (N% × 6.25) was estimated by the conventional micro-Kjeldahl method. Mineral matter and in vitro dry matter digestibility (IVDMD) were estimated by the methods of AOAC (1960) and Tilley and Terry (1963), as modified by Barnes et al. (1971), respectively. Tannin was estimated by the method of Burns (1971).

RESULTS AND DISCUSSION

The average crude protein content of the genotypes at four locations varied from 5.10 to 6.77% (see Supplementary Material Available paragraph at end of article). The highest protein percentage was observed at Parbhani, followed by Delhi, Amravati, and Hissar. The lowest average protein percentage of 5.10 at Hissar is due to higher dry matter production. The mean protein content of genotypes at the four locations varied from 5.19 to 7.03%. The highest was observed in JS-263 and the lowest in SL-44. The maximum deviation of 2.08% due to location was observed in Composite which showed 8.31% protein at Amravati as against the average of 6.23%. Deosthale and Mohan (1970) observed that varietal as well as locational differences were significant in grain sorghum for protein. Such locational differences in protein content have been reported in wheat (Pareira, 1944), maize (Curtis and Earle, 1946) and in barley (Grant and McCalle, 1949).

With regard to the structural components, the variation in neutral detergent fiber (NDF) content in the genotypes ranged from 63.39 to 67.84% and the highest value was observed for Composite and the lowest for IS 6090 (see Supplementary Material Available paragraph at end of article). The maximum variation due to location was 9.25% in NDF content, observed in SL-35. The average NDF content of all the genotypes at four locations varied from 59.24 to 69.21%. The lowest was at Parbhani and the highest at Delhi.

The average ADF content in the genotypes varied from 35.75 to 40.91%, while the average acid detergent fiber content (ADF) of all genotypes was highest at Delhi followed by Amravati, Hissar, and Parbhani. The maximum deviation of 7.05% in ADF content of SL-35 was observed due to location, whereas the remaining genotypes varied less (see Supplementary Material Available paragraph at end of article). The locational differences in NDF and ADF contents are primarily due to environment, i.e. the same genotype can behave differently at different locations. The two detergent extractions have been devised to provide residues which serve as direct measures of the plant fractions, which are slowly digested by the ruminants, the acid detergent residue representing a less digestible portion than the neutral detergent one (Van Soest, 1966; Van Soest and Wine, 1967). Deinum and Dirven (1972) reported that the temperature had a direct positive effect on percentage crude fiber of leaves and stems causing poor quality forage in warm climates.

The interesting finding of this investigation is that the tannin content is influenced significantly due to locational variations. Tannin has been observed to be a negative factor for the nutritive value of any sorghum genotypes. The mean value of tannin content in genotypes varied from 10.99 to 18.06 mg/g, while the locational mean value for tannin varied from 4.65 to 21.48 mg/g (see Supplementary Material Available paragraph at end of article). The lowest mean value of tannin was observed at Parbhani and the highest at Delhi followed by Hissar and Amravati. The mean values at Delhi and Hissar were more or less the same and may be due primarily to the similarities in environmental temperatures. Arora et al. (1974) report that the leaf portion contributes substantially to total

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tannin content. The present study is an agreement as shown by the observation that the highest tannin content was noted in Delhi sorghums which had the highest number of leaves per running meter. The lowest tannin and leaf content were observed at Parbhani. These differences in tannin content with location also might be due to soil fertility and season as the same genotypes were grown at different locations. Wilson (1955) reported a slight effect of K_2O on the tannin content of *Sericea lespedeza*. Clarke et al. (1939) and Stitt and Clarke (1941) observed seasonal variation in the tannin content of *Sericea lespedeza*. Stitt et al. (1946) also reported that a large part of the variation in tannin content was due to soil differences. Sievers and Clarke (1944) recorded a high seasonal change in the tannin content of the leaves of American sumac; samples taken in midsummer had considerably higher tannin content. The low content of tannin at Parbhani and Amravati is definitely due to temperature as the sowing was delayed there.

The in vitro dry matter digestibility data (see Supplementary Material Available paragraph at end of article) also reveal the locational influence on IVDMD of the genotypes. The maximum deviation of 9.90% in IVDMD was observed in SL-39 due to location, and the average value of IVDMD at Delhi was 61.93 followed in decreasing order by Parbhani, Amravati, and Hissar. The lowest value (52.07) of IVDMD at Hissar is mainly due to the highest dry matter production and higher tannin and lower protein content which also contribute toward the low IVDMD value. The differences in IVDMD values at different centers might be due to environment because all the samples have been analyzed with the rumen of the same source in the same run. The variability both within and between runs was low with the standard sorghum forage. A number of workers including Hiridoglou et al. (1966), Aldrich and Dent (1967), and Deinum et al. (1968) have reported the negative effect of temperature on in vitro dry matter digestibility.

The dry matter yield (see Supplementary Material Available paragraph at end of article) varied from 35 to 178 q/ha among the four stations. On an average the highest dry matter yield was observed at Hissar followed by Delhi, Amravati, and Parbhani. The average yield varied from 43.5 to 144.1 q/ha. The higher dry matter production at Hissar might be due to higher temperature during growth. Deinum and Dirven (1972) observed increased dry matter production at higher temperatures. The higher dry matter production is clearly evident from the data on leaf/stem ratio and stem girth at Hissar (see Supplementary Material Available paragraph at end of article). The leaf/stem ratio at Hissar was lowest, while at Parbhani it was highest. The stem girth was highest at Hissar followed by Amravati, Delhi, and Parbhani. It is generally the stem weight which contributes more toward dry matter production of any genotype. The lowest dry matter production at Parbhani is clear from its average stem girth (0.76 cm) as compared to 4.06 cm at Hissar. As regards the number of leaves/running meter, Delhi tops the list followed by Hissar, Amravati, and Parbhani. The maximum digestible dry matter (q/ha) was observed by JS-20 followed by SL-44 (see Supplementary Material Available paragraph at end of the article). Keeping in view both the digestible dry matter percentage and digestible dry matter (q/ha), the genotypes JS-20 and SL-44 are the best, followed closely by Composite.

Correlation Studies. Correlations between morphological characters and chemical components of nutritive value were also worked out (see Supplementary Material Available paragraph at the end of article). It is interesting to report that the tannin, ADF, and NDF contents were positively and significantly correlated with stem girth and number of leaves/running meter. The correlation between IVDMD and stem girth was negatively significant. Though the relationship between IVDMD and number of leaves/running meter was positive, it was not significant.

CONCLUSIONS

Experiments were conducted with forage sorghums to determine the effect of location on chemical and morphological character. Variability in all the chemical and morphological characters was observed. Neutral and acid detergent fiber and tannin contents were positively and significantly correlated with stem girth, whereas in vitro dry matter digestibility was negatively and significantly associated with stem girth. It is, therefore, attributed that varieties with low stem girth should be selected for better nutritive value.

ACKNOWLEDGMENTS

The authors wish to thank Kanwar Singh, Additional Director of Research, for providing necessary research facilities and Shankar Lal Sharma for his help in analytical work.

Supplementary Material Available. The data at different locations pertaining to protein, neutral detergent fiber, acid detergent fiber, dry matter yield, in vitro dry matter digestibility, digestible dry matter, tannin, stem girth, number of leaves/running meter, leaf/stem ratio, and correlation coefficients between different constituents will appear following these pages in the microfilm edition of this volume of the journal. Photocopies of the supplementary material from this paper only or microfiche (105 × 148 mm, 24× reduction, negatives) containing all of the supplementary material for the papers in this issue may be obtained from the Journals Department, American Chemical Society, 1155 16th St., N.W., Washington, D.C. 20036. Remit check or money order for $4.00 for photocopy or $2.50 for microfiche, referring to code number JAFC-75-543.

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Received for review May 31, 1974. Accepted January 24, 1975.