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QUALITY CONTENTS OF FODDER AS INFLUENCED BY DIFFERENT PERENNIAL FODDER INTERCROPPING SYSTEMS

ROOPA K. MUTTAPPANAVAR[1]* AND B. G. SHEKARA[2]

[1]Department of Agronomy, UAS, GKVK, Bengaluru-560065 (Karnataka), India
[2]AICRP on Forage Crops, Zonal Agricultural Research Station, V. C. Farm, Mandya-571405 (Karnataka), India
(e-mail: roopakm6813@gmail.com)

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SUMMARY

The experiment was conducted during July-2020 to June-2022 at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya, University of Agricultural Sciences, Bangalore, Karnataka to study the quality content of fodder under different perennial fodder cropping systems under irrigated condition. The experiment was laid out in randomized complete block design consisted of twelve treatments and replicated thrice. The two years pooled data revealed that, among different grass-legume mixtures, paired row system of B×N hybrid + *Desmanthus* (2:5) recorded significantly higher dry matter intake (2.41%), digestible dry matter (63.71%), total digestible nutrients (59.60%), relative feed value (119.2%), cell content (50.24%) and lower hemicelluloses content (17.42%) which was on par with paired row system of Guinea grass + *Desmanthus* (2:3) as compared to other grass-legume mixtures. These results are further evidenced by strong negative correlation between acid detergent fibre (ADF) and DDM (r^2=-0.99) of fodder (Fig. 1), neutral detergent fibre (NDF) and DMI (r^2=-0.98) (Fig. 2), TDN and ADF (r^2=-0.99) (Fig. 3), RFV and NDF (r^2=-0.97), NDF and cell content of fodder (r^2=-0.99) (Fig. 5) and strong positive correlation between RFV and DDM (r^2=0.99) and DMI (r^2=0.98) (Fig. 4). Thus, B×N hybrid paired row + *Desmanthus* (2:5) followed by Guinea grass paired row + *Desmanthus* (2:3) were identified as best perennial fodder intercropping systems for meeting the demand of quality green fodder.

Key words: *Desmanthus,* perennial grass fodders, intercropping systems, quality contents

Quality of forage and fodder crops is the major drawback of the livestock sector in the country. There is a need to bridge the gap between the supply and demand of quality fodder through the adoption of specific sustainable fodder production strategies. Livestock are major component of the global agricultural production systems. The shift from calorie-based diets to protein rich diets of the burgeoning population gave impetus to grass-legume based livestock production in last few decades. Moreover, it offers a livelihood opportunity for the global smallholder farming community. In India, livestock production is mainly based upon mixed farming, in which farmers often integrate crops and livestock to maximize income and diversify the use of available resources. On the contrary, the availability of green fodder is 734.2 million tonnes in the country which is less than the requirement (827.19 million tonnes) with a net deficit of 11.24 per cent (Roy *et al.,* 2019). At present, only 8.4 m ha cultivated area is devoted to fodder production in the country. Thus a wide gap exists between the supply and demand of quality green fodder with increasing livestock population in the country. In this context, there is a need to increase the productivity of fodder within the available land. On the other hand, the availability of quality fodder is considered as the prime limiting factor for decline in the potential of dairy sector (Prajapati *et al.,* 2018). Thus, in addition to increasing the yield there is also a prerequisite of quality green fodder production. Hence, adoption of perennial grasses and legume fodder cropping systems with improved varieties will provide an opportunity to bridge the gap between supply and demand of quality green fodder by increasing the productivity per unit area and time. On the other side, inclusion of legume fodder as component crop along with the cereal fodder is most common but the exploitation of rarely used perennial fodder legume such as *Desmanthus* is very meager even though it's having many advantages over common lucerne crop. In this background the present study was undertaken with an aim to identify the best grass and *Desmanthus* based intercropping system for round the year production of quality green fodder. Here, cultivation of perennial grass/ cereal fodder crops *viz.,* B×N hybrid, guinea grass and perennial fodder sorghum as main crops and perennial fodder legume *Desmanthus* as intercrop at different row ratio were assessed.

MATERIALS AND METHODS

To identify the qualitative fodder production potential of different perennial fodder cropping systems, the current experiment was conducted during 2020-21 and 2021-22 at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya, Karnataka under irrigated condition using randomized complete block design. The experiment consisted of 12 treatments which comprised different fodder cropping systems *viz.,* T_1: B×N hybrid + *Desmanthus* (1:1), T_2: B×N hybrid + *Desmanthus* (2:1), T_3: B×N hybrid + *Desmanthus* (Paired row of B×N hybrid as 60 cm within the pair and 180 cm between the pair with 2:5 row ratio), T_4: Guinea grass + *Desmanthus* (1:1), T_5: Guinea grass + *Desmanthus* (2:1), T_6: Guinea grass + *Desmanthus* (Paired row of guinea grass as 45 cm within the pair and 120 cm between the pair with 2:3 row ratio), T_7: Perennial fodder sorghum + *Desmanthus* (4:1), T_8: Perennial fodder sorghum + *Desmanthus* (8:2), T_9: B×N hybrid (Sole), T_{10}: Guinea grass (Sole), T_{11}: Perennial fodder sorghum (Sole) and T_{12}: *Desmanthus* (Sole). The soil of the experimental site was sandy loam in texture with neutral in reaction (7.44). The nutritional status of soil was medium in organic carbon (0.51 %), low in available nitrogen (263.42 kg ha^{-1}), medium in available phosphorous (47.61 kg ha^{-1}) and available potassium (161.28 kg ha^{-1}). The crops were established as per the recommended package of practices. All the selected fodder species have properties of rapid filed establishment, withstand heavy pruning, good regeneration capacity and suitable for cut and carry method of feeding system in Southern Dry Zone of Karnataka. The first harvest of B×N hybrid, guinea grass, sorghum and *Desmanthus* was done at 75 days after planting and sowing by leaving stubbles at height of 10-15 cm above the soil and subsequent harvests at 45 days interval in B×N hybrid, sorghum and *Desmanthus* while, 32 days interval in guinea grass. Immediately after harvest of the crop green fodder yield was recorded and a known quantity of sample was taken and oven-dried for the estimation of quality parameters. The digestible dry matter (DDM), dry matter intake (DMI), total digestible nutrients (TDN) and relative feed value (RFV) were calculated according to the following formula adopted from Horrocks and Vallentine (1999): DMD (%) = 88.9 - (0.779 × % ADF, dry matter basis); DMI (% of body weight) = 120/(%NDF on dry matter basis); TDN (%) = (-1.291 × ADF %) + 101.35; RFV (%) = % DDM × % DMI × 0.775. The cell content and hemicellulose content was calculated from the equation of Prajapati (2017): Cell content (%) = 100 - NDF (%); Hemicellulose (%) = NDF % - ADF %. The data of two years were statistically analyzed and interpreted on pooled basis.

RESULTS AND DISCUSSION

Digestible dry matter

The pooled data indicated that, the sole cropping system of *Desmanthus* recorded significantly higher digestible dry matter content (66.80 %) (Table 1). Whereas, the lower digestible dry matter content was recorded by sole perennial fodder sorghum (55.38 %) and found on par with sole B×N hybrid (55.92 %). Among different intercropping systems, paired row system of B×N hybrid + *Desmanthus* (2:5) recorded significantly higher digestible dry matter content (63.71 %) which was on par with paired row system of Guinea grass + *Desmanthus* (2:3) (63.06 %) but superior over other grass-legume intercropping systems. The higher digestible dry matter content was mainly attributed to more crude protein, lower fibre content and more succulent nature of *Desmanthus* both under intercropping and sole cropping helps in easy digestion by microbes in rumen. This was further evidenced by strong negative correlation between acid detergent fibre and digestible dry matter content (r^2 = -0.99) of fodder (Fig. 1). This is also due to higher accumulation of cell wall contents which acts as physical barrier to microbial enzymes for reacting with their target polysaccharides. These results are in accordance with the findings of Karayilanli and Ayhan (2016), Prajapati (2016), Jagadeesh *et al.* (2017), Prajapati *et al.* (2019) and Prajapati *et al.* (2020).

Dry matter intake

The sole cropping system of *Desmanthus* recorded significantly higher dry matter intake (2.78 %) on pooled basis and the lower dry matter intake was observed with monoculture of perennial fodder sorghum (1.71 %) which was at par with sole crop of B×N hybrid (1.81 %) (Table 1). Among different grass-legume mixtures, significantly higher dry matter intake of 2.41 per cent was recorded by paired row system of B×N hybrid + *Desmanthus* (2:5) and it was on par with Guinea grass + *Desmanthus* (2:3) in a paired system (2.33 %) than other grass-legume intercropping systems. The higher dry matter intake with sole crops of *Desmanthus* and it's higher

TABLE 1

Digestible dry matter (DDM), dry matter intake (DMI) and total digestible nutrient (TDN) contents of different perennial fodder cropping systems (Pooled data)

Treatment	DDM (%)	DMI (%)	TDN (%)
T_1: B×N hybrid + *Desmanthus* (1:1)	61.37	2.19	55.73
T_2: B×N hybrid + *Desmanthus* (2:1)	59.55	2.05	52.71
T_3: B×N hybrid + *Desmanthus* (2:5) (Paired row: 60 cm x 180 cm)	63.71	2.41	59.60
T_4: Guinea grass + *Desmanthus* (1:1)	62.10	2.24	56.94
T_5: Guinea grass + *Desmanthus* (2:1)	60.53	2.10	54.33
T_6: Guinea grass + *Desmanthus* (2:3) (Paired row: 45 cm x 120 cm)	63.06	2.33	58.53
T_7: Perennial fodder sorghum + *Desmanthus* (4:1)	57.68	1.86	49.61
T_8: Perennial fodder sorghum + *Desmanthus* (8:2)	57.68	1.86	49.61
T_9: B×N hybrid (Sole)	55.92	1.81	46.70
T_{10}: Guinea grass (Sole)	57.40	1.87	49.14
T_{11}: Perennial fodder sorghum (Sole)	55.38	1.71	45.80
T_{12}: *Desmanthus* (Sole)	66.80	2.78	64.72
S.Em ±	0.53	0.04	0.88
CD (p=0.05)	1.55	0.11	2.57

proportion in intercropping system might be attributed to higher crude protein and lower neutral detergent fibre content as evidenced by strong negative correlation between neutral detergent fibre and dry matter intake of fodder (r^2 = -0.98) (Fig. 2). Apart from these, legumes as intercrops with cereal crops have been found to reduce the fiber content of the system which indicates higher palatability and digestibility of fodder which might have resulted in higher fodder intake Karayilanli and Ayhan (2016), Prajapati *et al.* (2018) and Manoj *et al.* (2020).

Total digestible nutrients

The monoculture of *Desmanthus* recorded significantly higher total digestible nutrients (64.72 %). However, the sole perennial cropping system of sorghum recorded lower total digestible nutrients (45.80 %) and it was on par with monoculture of B×N hybrid (46.70 %) on pooled basis (Table 1). Among different grass-legume intercropping systems, significantly higher total digestible nutrients were recorded by paired row system of B×N hybrid + *Desmanthus* (2:5) (59.60 %) which was at par with paired row system of Guinea grass + *Desmanthus* (2:3) (58.53 %) than other intercropping systems. The higher acid detergent fibre in fodder results in lesser availability of nutrients due to reduced palatability and digestibility of fodder. Thus, lower acid detergent fibre associated with sole *Desmanthus* and paired row system of grass-legume fodder cropping systems might be the reason for their higher total digestible nutrients content in the fodder and it was evidenced by strong negative correlation between total digestible nutrients and acid detergent fibre content (r^2 = -0.99) (Fig. 3). The similar kinds of results were also noticed

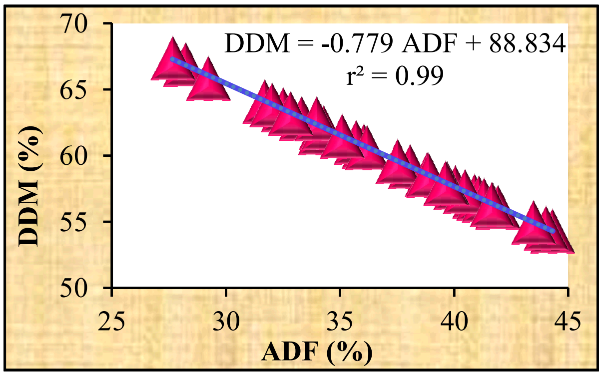

Fig. 1. Relationship between acid detergent fibre (ADF) and digestible dry matter content (DDM) of different perennial fodder cropping systems.

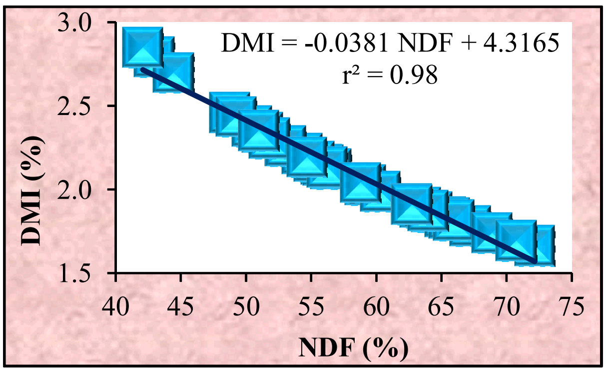

Fig. 2. Relationship between neutral detergent fibre (NDF) content and dry matter intake (DMI) of different perennial fodder cropping systems.

by Karayilanli and Ayhan *et al.* (2016), Yadav *et al.* (2019) and Manoj (2020).

Relative feed value

The perennial cropping system involving sole *Desmanthus* resulted in significantly higher relative feed value (144.0 %) which was superior over all other cropping systems. The sole perennial cropping system of sorghum recorded significantly lower relative feed value (73.6 %) and found on par with sole B×N hybrid (78.6 %) on pooled basis (Table 2). Among grass-legume intercropping systems, significantly higher relative feed value of 119.2 per cent was registered with paired row system of B×N hybrid + *Desmanthus* (2:5) which was at par with paired row system Guinea grass + *Desmanthus* (2:3) (114.0 %) and superior over other grass-legume intercropping systems. The legume component in cropping systems resulted higher crude protein and reduced fibre fractions and that lead to higher relative feed value. This was further evident by strong negative correlation between relative feed value and neutral detergent fibre (r^2 = -0.97), positive correlation between relative feed value and digestible dry matter content (r^2 = 0.99) and dry matter intake (r^2 =0.98) (Fig. 4). These results are in accordance with the finding of Karayilanli and Ayan (2016) and Manoj (2020).

Cell content

Significantly higher cell content was registered with sole crop of *Desmanthus* (56.83 %) and lower cell content was recorded by monoculture of perennial fodder sorghum (29.95 %) on pooled basis (Table 2). Among different grass-legume mixtures, paired row system of B×N hybrid + *Desmanthus* (2:5) recorded significantly higher cell content (50.24 %) which was on par with paired row system Guinea grass + *Desmanthus* (2:3) (48.51 %) and superior than all other grass-legume mixtures. The higher cell content is a sign of good quality fodder. Leguminous fodder rich in protein content and lower in neutral detergent fibre

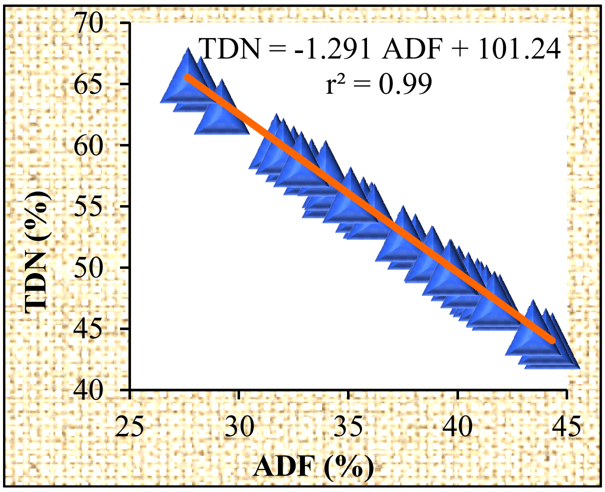

Fig. 3. Relationship between acid detergent fibre (ADF) and total digestible nutrients (TDN) of different perennial fodder cropping systems.

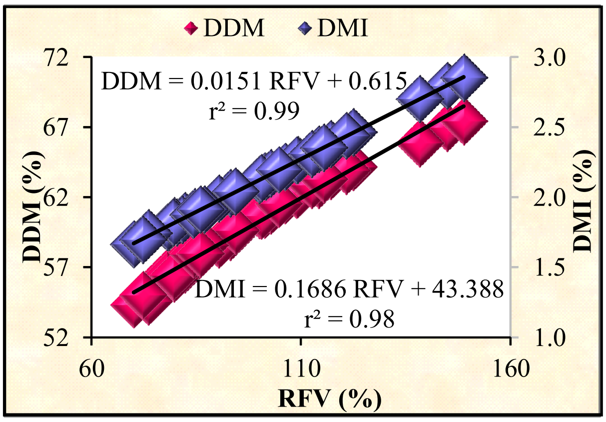

Fig. 4. Relationship of relative feed value (RFV) with dry matter intake (DMI) and digestible dry matter content (DDM) of different perennial fodder cropping systems.

content might be the reason for improved cell content of the fodder both in sole *Desmanthus* and grass-

TABLE 2

Relative feed value (RFV), cell content and hemicellulose content of different perennial fodder cropping systems (Pooled data)

Treatment	RFV (%)	Cell content (%)	Hemicellulose content (%)
T_1: B×N hybrid + *Desmanthus* (1:1)	104.4	45.29	19.37
T_2: B×N hybrid + *Desmanthus* (2:1)	94.7	41.43	20.90
T_3: B×N hybrid + *Desmanthus* (2:5) (Paired row: 60 cm x 180 cm)	119.2	50.24	17.42
T_4: Guinea grass + *Desmanthus* (1:1)	107.8	46.40	19.20
T_5: Guinea grass + *Desmanthus* (2:1)	98.7	42.92	20.66
T_6: Guinea grass + *Desmanthus* (2:3) (Paired row: 45 cm x 120 cm)	114.0	48.51	18.33
T_7: Perennial fodder sorghum + *Desmanthus* (4:1)	83.0	35.35	24.58
T_8: Perennial fodder sorghum + *Desmanthus* (8:2)	83.1	35.35	24.57
T_9: B×N hybrid (Sole)	78.6	33.74	23.93
T_{10}: Guinea grass (Sole)	83.4	35.97	23.59
T_{11}: Perennial fodder sorghum (Sole)	73.6	29.95	27.03
T_{12}: *Desmanthus* (Sole)	144.0	56.83	14.80
S.Em ±	2.6	1.09	0.400
CD (p=0.05)	7.5	3.18	1.16

legume intercropping systems. There is a strong negative correlation between neutral detergent fibre and cell content of fodder (r^2 = -0.99) (Fig. 5). The results are in agreement with the findings of Prajapati *et al.* (2018) and Manoj (2020).

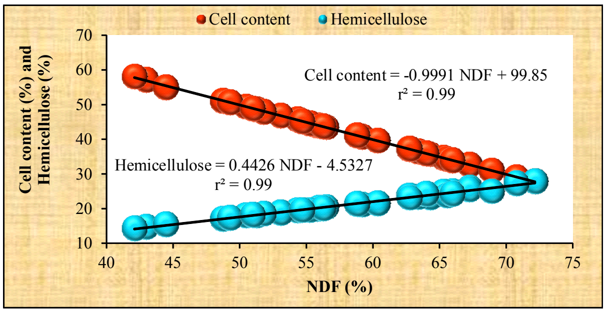

Fig. 5. Relationship of neutral detergent fibre (NDF) with cell content and hemicellulose content of different perennial fodder cropping system.

Hemicellulose content

The sole perennial cropping system of sorghum recorded significantly higher hemicellulose content (27.03 %) on pooled basis (Table 2). However, the lower hemicellulose was recorded by sole *Desmanthus* (14.80 %). Among different grass-legume intercropping systems, significantly lower hemicellulose content of 17.42 per cent was recorded by paired row system of B×N hybrid + *Desmanthus* (2:5) which was on par with paired row system Guinea grass + *Desmanthus* (2:3) (18.33 %) as compared to other grass-legume intercropping systems. Generally, the fodder with lower hemicellulose content is of good quality. The lower hemicellulose content with sole *Desmanthus* might be due to higher crude protein content along with lower fibre fractions of the fodder. This was further evidenced by strong positive correlation between hemicellulose and neutral detergent fibre (r^2 = 0.99) (Fig. 5). These results are in conformity with the findings of Das *et al.* (2015), Senthil *et al.* (2016), Jagadeesh *et al.* (2017) and Manoj (2020).

Among different grass-legume intercropping systems, paired row system of B×N hybrid + *Desmanthus* (2:5) followed by paired row system of Guinea grass + *Desmanthus* (2:3) out performed with higher digestible dry matter, dry matter intake, total digestible nutrients, relative feed value and cell contents with lower hemicellulose content of fodder. Thus, these two perennial grass-legume intercropping systems will provide a way for quality green fodder production around the year.

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