Nutritive Value and Utilization of Perennial Grasses Intercropped with Soybean Fodder by Crossbred Heifers in Humid-subtropics of Himachal Pradesh

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ABSTRACT : A study was carried out to investigate the nutritive value and utilization of hybrid sorghum and perennial grass species viz. setaria (*Setaria anceps*) and hybrid napier when intercropped with soybean by growing Jersey crossbred heifers. Fifteen growing crossbred heifers (Jersey×Red Sindhi) of between 7-10 months age and pre-trial average body weight of 49-50 kg were divided on the basis of weight in to three treatment groups viz. T_1-hybrid sorghum+soybean, T_2-setaria+soybean and T_3-hybrid napier+soybean in a completely randomized block design. Intercropped forages were harvested fresh, chaffed and mixed before they were offered to the heifers. Chemical composition of the herbage, dry matter intake (DMI), body weight gain and nutrient digestibility co-efficients were estimated. The herbage mixtures had crude protein (CP) content in the range of 11.87 to 13.86% and ether extract (EE) contents were 2.91 to 3.11%, respectively. The herbage mixtures were rich in minerals (ash). The gross energy (kcal/g DM) was higher in hybrid napier+soybean, while hybrid sorghum+soybean and setaria+soybean herbage mixtures had lower value for gross energy. The hybrid sorghum+soybean and setaria+soybean herbage mixtures had higher contents of NDF, ADF, cellulose, lignin and silica as compared to that of hybrid napier+soybean herbage mixture. The heifers fed hybrid napier+soybean herbage mixture had significantly ($p<0.05$) higher DMI g/kg $W^{0.75}$ (97.41±4.34) as compared to hybrid sorghum+soybean (88.31±2.66) and setaria+soybean (79.29±1.06) herbage mixtures. Nutrients digestibility, DCP percent, DCP intake and nitrogen balance were significantly ($p<0.05$) higher in the heifers fed on hybrid napier+soybean herbage mixture. There was a significant ($p<0.05$) difference among different herbage mixtures in TDN. The heifers on setaria+soybean herbage mixture had lower average body weight gain (g/day) than those on hybrid sorghum+soybean and hybrid napier+soybean herbage mixtures. Data obtained in this experiment demonstrated that herbage mixture of hybrid napier+soybean was better than hybrid sorghum+soybean and setaria+soybean herbage mixtures in the nutrition of growing heifers. It had highest nutritive value, better digestibility co-efficients which showed better growth rate and higher feed efficiency. In ranking, hybrid napier+soybean herbage mixture was better followed by hybrid sorghum+soybean and setaria+soybean in nutritive value in the parameters studied. For future wasteland development program in humid-sub tropics of Himachal Pradesh hybrid napier and its intercropping with soybean is recommended for general adoption because of its better adaptability and higher nutritive value. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 12 : 1754-1759)***

Key Words : Perennial Grasses, Intercropping, Chemical Composition, DMI, Growth Rate, Feed Efficiency, Digestibility, Cattle

INTRODUCTION

In the humid- subtropics of Himachal Pradesh, the major source of roughage (green as well as dry) for feeding of livestock are the mixed green grasses available during monsoons from the local grasslands and wastelands, tree leaves, besides, crop residues like paddy straw, wheat straw, maize stovers etc. Increasing human population and growing preference for cultivating food and commercial crops are sparing only a limited area for fodder production. The qualitative and quantitative insufficiency of the palatable fodder in the region is primarily responsible for poor performance of local as well as highly valued Jersey and Jersey crossbred animals. To bridge the gap between green fodder availability and its requirements, use of wastelands with improved forage varieties and their intercropping with legumes and adoption of improved agronomic methods are necessary. The production of fodder of high feeding value is necessary when prospects are limited in increasing the cultivated land area. One of the methods to achieve quality and quantity of nutrients is intercropping of non-legume forages with legumes and which also improves the productivity of land due to N fixation to soil by legumes (Rao et al., 1988). Legumes added to grass diets improve nutritional condition in several ways including an improved ratio of amino acids to energy derived from absorbed digestion products and required by tissues (Egan, 1977). Greater intake of legume than of grass is partially responsible for superior performance by ruminants (Reid et al., 1990). High live weight gain or milk production by ruminants requires a high intake of forage with high digestibility of the cell wall (Wilson, 1993). There are reports of intercropping of grasses with legumes by Singh et al. (1978), Patil et al. (1983) and Thakuria and Sarma (1998) with respect to biomass production and chemical composition but, scant information is available on the chemical composition, nutritive value and biological performance in heifers fed grasses intercropped with legumes. The objective of this paper therefore, was to

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evaluate hybrid sorghum, perennial grasses viz. setaria and hybrid napier intercropped with soybean in diets of growing Jersey crossbred heifers.

MATERIALS AND METHODS

Site of the experiment

The experiment was conducted at metabolic stall of college of the veterinary and Animal Sciences, CSK HPKV, Palampur, Himachal Pradesh (H.P.) during kharif season. The site is situated at an elevation of 1,290 m above mean sea level and lies at 32.6°N latitude and 76.3°E longitude. The area represents mid-hill zone of H.P. and is characterized by the cool sub-tropical climate. Rainfall ranges between 2,000 to 2,500 mm and 80 percent of it is received during June to September and rest in winter months, the mean annual minimum and maximum temperature ranges between 5.7 to 20.0 and 15.0 and 31.1°C with humidity of 29 to 85%. This experiment was conducted between late June and early September, 2000.

Diets

The diets consisted of mixed forages of hybrid sorghum+soybean control (T_1), setaria+soybean (T_2) and hybrid napier+soybean (T_3). The intercropped grasses were harvested fresh, chaffed, mixed and fed to the animals *ad libitum* to allow about 10-20% refusal. An adaptation period of 15 days was allowed for the heifers to get used to the experimental diets before data collection started. Diets offered and refused were recorded on a daily basis to estimate voluntary dry matter intake. Cleaning of the pens and removal of refusals from the pervious day was done daily before supplying each days diet. All the animals were provided *ad libitum* water twice daily.

Animals and experimental design

Fifteen growing crossbred heifers (Jersey×Red Sindhi) between 7 to 10 months of age and pre-trial average live weight 49.0 to 50 kg were divided on the basis of weight in to three treatment groups viz. T_1-hybrid sorghum+soybean, T_2-setaria+soybean and T_3-hybrid napier+soybean in a completely randomized design. In each treatment there were five heifers. The heifers were housed in individual pens that had previously been disinfected. They were drenched with a dewormer (Albendazole) prior to the start of the experiment.

Digestibility study

During the growth trial, the heifers in each group were used for metabolic studies. A 5 days metabolic trial was conducted in the second fortnight. The total daily feed output for each heifer was weighed and 1/100th of it was taken for dry matter determination and chemical analyses. The daily samples of faces and diets were then bulked separately, oven dried, milled and stored in airtight bottles until required for analysis. 24 h urine output of individual heifer was measured and 1/100th was preserved in 10% sulphuric acid separately and stored in a stoppered bottle for N-estimation. Digestibility was calculated by difference. The nitrogen content for balance studies was determined from preserved pooled samples of feces and urine.

Analytical procedures

The forage offered, residual and fecal samples were oven dried at 70°C for 24 h. All dried materials were ground to pass through 1 mm sieve. Dry matter was determined by drying at 100°C for 24 h, ash by firing at 600°C for 6 h, protein by the micro kjeldahl procedure (N×6.25) following the procedure of AOAC (1995). Minerals of calcium, copper, zinc and manganese were determined by Atomic Absorption spectrophotometer (AAS) Model 3100, Perkin Elmer, U.S.A while, phosphorus was determined by the method of Humphries (1973) from the filtrate obtained during silica determination. Gross energy in herbage mixtures was determined by using Advance Bomb Calorimeter.

Body weight gain

The body weight of heifers were recorded fortnightly before offering morning feed and water. Daily gains in weight were calculated according to method described by Brody (1945).

Statistical analysis

The data pertaining to present investigation were subjected to statistical analysis by the method described by Snedecor and Cochron (1967).

RESULTS

Mean of dry matter (DM) and chemical composition of the different herbage mixtures fed to the heifers are presented in the Table 1. Hybrid sorghum+soybean herbage mixture had higher DM content than herbage mixtures of setaria+soybean and hybrid napier+soybean. The herbage mixtures had higher CP contents and were with in the range of 11.87 to 13.86%. The hybrid napier+soybean mixture had higher contents of ether extract (EE) and gross energy as compared to other herbage mixtures. The herbage mixture of hybrid napier+soybean had lower contents of ADF, cellulose, lignin and silica (Table 1). Table 2 shows the mineral concentrations in the grass mixtures. The content of calcium was lower while phosphorus was higher in hybrid napier and soybean herbage mixture than setaria and soybean and hybrid sorghum and soybean herbage mixtures. The setaria+soybean herbage mixture was richer in iron and manganese contents.

Table 1. Chemical composition of herbage mixtures (% in DM)

Parameter	Hybrid sorghum +soybean (T_1)	Setaria +soybean (T_2)	Hybrid napier +soybean (T_3)
Dry matter	15.63	13.51	13.43
Crude protein	12.02	11.87	13.86
Ether extract	2.91	2.53	3.11
Organic matter	89.22	88.02	89.98
Total ash	10.78	11.98	11.02
Gross energy (kcal/g DM)	3.96	3.87	4.08
Neutral detergent fiber	56.98	65.53	62.04
Acid detergent fiber	42.72	42.39	36.71
Hemicellulose	14.26	23.14	27.33
Cellulose	29.98	30.62	25.40
Lignin	6.57	5.83	5.14
Silica	6.17	5.94	4.17

* Each value is a mean of duplicate determinations.

Table 2. Mineral concentrations in the herbage mixtures

Parameter	Hybrid sorghum+ soybean (T_1)	Setaria+ soybean (T_2)	Hybrid napier+ soybean (T_3)
Macro-minerals (% in DM)			
Calcium (Ca)	1.92	1.85	1.39
Phosphorus (P)	0.41	0.39	0.65
Micro-minerals (mg/kg DM)			
Copper (Cu)	17.33	12.93	15.68
Zinc (Zn)	32.90	35.82	32.17
Iron (Fe)	200.03	231.03	217.55
Manganese (Mn)	58.16	81.35	48.44

Each value is a mean of duplicate determinations.

Data on voluntary dry matter intake (DMI) are presented in Table 3. Average dry DMI kg/100 kg body weight (BW) and g/kg $W^{0.75}$ was significantly ($p<0.05$) higher in hybrid napier+soybean than those of hybrid sorghum+soybean and setaria+soybean treatments. Nutrients digestibility were significantly ($p<0.05$) higher in hybrid napier+soybean than hybrid sorghum+soybean and setaria+soybean treatment animals (Table 4). The heifers fed hybrid sorghum+soybean were better in digestibility co-efficients of CP, and NDF than those on setaria+soybean. However, the ADF digestibility co-efficient in setaria+ soybean was significantly ($p<0.05$) higher than hybrid sorghum+soybean.

The nutritive values of the herbage mixtures under different treatments as digestible crude protein (DCP) and total digestible nutrients (TDN) and DCP and TDN intakes are shown in Table 5. Hybrid napier+soybean herbage mixture contained significantly ($p<0.05$) more DCP and higher DCP intake than hybrid sorghum+soybean and setaria+soybean herbage mixtures. There was significant difference ($p<0.05$) amongst hybrid napier+soybean, hybrid sorghum+soybean and setaria+soybean herbage mixtures in TDN. The intake of TDN (g/kg $W^{0.75}$) was significantly ($p<0.05$) higher in hybrid napier+soybean mixture treatment. The heifers on hybrid sorghum+soybean had significantly ($p<0.05$) higher TDN intakes than heifers of setaria+soybean herbage mixture.

The nitrogen intake and nitrogen retention g/day were significantly ($p<0.05$) higher in hybrid napier+soybean herbage fed animals (Table 6). The data showed positive nitrogen balance for all the animals fed different herbage mixtures, however, the values were significantly ($p<0.05$) higher in hybrid napier+soybean than hybrid sorghum+ soybean and setaria+soybean treatments.

Table 7 shows the body weight gain in heifers fed on different herbage mixtures. Data showed that growing heifers fed on hybrid napier+soybean had more body weight gain as compared to other treatment animals.

DISCUSSION

The herbage mixture of hybrid sorghum and soybean had higher DM content which may be due to low leaf: stem ratio and plant species difference (Dougall and Bogdon. 1958). The CP contents were higher in the herbage mixtures ranging 11.87 to 13.86% because of intercropped soybean fodder and the results are in agreement with the results of Patil et al. (1983) and Tripathi (1989). The EE content of the herbage mixtures hybrid sorghum+soybean, setaria+ soybean and hybrid napier+soybean was 2.91, 2.53 and 3.83 percent, respectively. The gross energy values of respective herbage mixtures were 3.96, 3.87 and 4.08 kcal/g DM. Higher values of gross energy in hybrid napier and soybean herbage mixture corresponded to its higher EE content and the difference may be due to plant species difference and leaf: stem ratio. The forage mixtures had high OM content suggesting that they can support overall animal performance. Hybrid napier+soybean herbage mixture had lower contents of ADF, cellulose,lignin and silica suggesting the herbage mixture to be more palatable, nutritious and digestible. Increasing fibrosity reduces digestion rate and causes a consequence of decreased feed intake capacity (Faverdin et al., 1995) and, lignification and silica limit cell wall degradation (Besle et al., 1995).

The herbage mixtures have relatively higher total mineral content (ash). The macro and trace minerals are a true reflection of the ash content (Aregheri, 2001). Ca and P are very important minerals and generally, Ca is not usually deficient. In the present study the contents of Ca were high in herbage mixtures as compared to P. The range forages and legumes often have high levels of Ca in relation to P (Norton, 1994). The P requirement in forage for growing

Table 3. Body weights of experimental heifers and their dry matter intakes of different treatment herbage mixtures during metabolic trial

Parameter	Hybrid sorghum+soybean (T_1)	Setaria+soybean (T_2)	Hybrid napier+soybean (T_3)	CD 5%
Initial body weight (kg)	59.188±4.51	60.875±6.02	61.125±8.30	
Final body weight (kg)	62.625±4.90	63.000±6.60	65.750±8.87	
DMI (kg) per head/day	1.932±0.17	1.765±0.15	2.203±0.32	NS
DMI (kg)/100 kg body weight	3.165^{b}±0.04	2.827^{a}±0.04	3.467^{c}±0.09	0.23
DMI (g)/kg $W^{0.75}$	88.308^{b}±2.66	79.285^{a}±1.66	97.408^{c}±4.34	8.72

[a,b,c] Means on the same row having unlike superscripts differ significantly ($p<0.05$).

Table 4. Mean apparent nutrient digestibility co-efficients in heifers fed on herbage mixtures

Parameter	Hybrid sorghum+soybean (T_1)	Setaria+soybean (T_2)	Hybrid napier+soybean (T_3)	CD 5%
Dry matter	54.10^{a}±0.75	54.58^{a}±1.97	61.96^{b}±1.08	3.66
Crude protein	65.40^{b}±0.90	63.15^{a}±1.47	77.14^{c}±0.88	3.59
Ether extract	53.57^{a}±0.78	56.30^{a}±1.47	60.11^{b}±1.21	3.27
Neutral detergent fiber	61.35^{b}±0.89	55.98^{a}±2.05	59.92^{b}±1.40	3.22
Acid detergent fiber	42.23^{a}±0.81	51.08^{b}±1.36	55.41^{c}±0.97	2.68
Hemicellulose	59.73^{a}±2.21	62.05^{a}±3.53	65.01^{b}±2.57	2.57
Cellulose	52.31^{a}±1.31	52.67^{a}±1.12	58.45^{b}±1.01	3.26

[a,b,c] Means on the same row having unlike superscripts differ significantly ($p<0.05$).

Table 5. Nutritive value of the herbage mixtures

Parameter	Hybrid sorghum+ soybean (T_1)	Setaria− soybean (T_2)	Hybrid napier+ soybean (T_3)	CD 5%
Digestible crude protein (%)	7.86^{b}±0.11	7.29^{a}±0.17	10.69^{c}±0.12	0.23
Digestible crude protein intake kg/head/day	0.152^{a}±0.02	0.133^{a}±0.01	0.236^{b}±0.04	0.07
Digestible crude protein intake kg/100 kg body weight	0.249^{b}±0.01	0.212^{a}±0.02	0.371^{c}±0.02	0.03
Digestible crude protein intake g/kg $w^{0.75}$	6.95^{a}±0.30	5.89^{a}±0.17	10.43^{c}±0.55	0.26
Total digestible nutrients (%)	54.32^{b}±1.27	52.06^{a}±1.29	58.55^{c}±1.13	3.26
Total digestible nutrients intake kg/head/day	1.056^{a}±0.12	0.925^{a}±0.10	1.256^{b}±0.21	0.19
Total digestible nutrients intake kg/100 kg body weight	1.720^{b}±0.06	1.471^{a}±0.03	1.961^{c}±0.07	0.18
Total digestible nutrients intake g/kg $w^{0.75}$	48.07^{b}±2.58	41.32^{a}±1.57	55.20^{c}±3.47	3.61

[a,b,c] Means on the same row having unlike superscripts differ significantly ($p<0.05$).

Table 6. Nitrogen balance in experimental heifers

Parameters	Hybrid sorghum+ soybean (T_1)	Setaria+ soybean (T_2)	Hybrid napier+ soybean (T_3)	CD 5%
a) Nitrogen intake g/head/day (NI)	39.20^{a}±3.13	36.64^{a}±3.09	51.79^{c}±6.99	7.03
b) Nitrogen excretion g/head/day	13.51±0.76	13.40±0.94	11.74±1.38	
i)Faeces	10.19±0.80	12.83±0.64	14.15±1.11	
ii)Urine				
c) Nitrogen excretion % of intake	34.66±0.88	36.77±1.49	22.86±0.86	
i) Faeces	26.45±3.01	35.77±3.62	28.41±3.39	
ii) Urine				
d) Nitrogen retained g/head/day (NR)	15.50^{a}±2.49	10.42^{a}±2.53	25.90^{c}±5.43	6.70
e) NR/NI (%)	38.90^{b}±3.80	27.46^{a}±4.90	48.73^{c}±3.45	8.58

[a,b,c] Means on the same row having unlike superscripts differ significantly ($p<0.05$).

heifers is 0.29 to 0.42% of DM (NRC, 1989), thus the P content of the three herbage mixtures used in this study seemed to satisfy the P requirement of the animals (Table 2). The variations in the macro and micro minerals in different herbage mixtures were due to plant species difference (Dougall and Bogdon, 1958), proportion of grasses and green soybean, morphological components and genetic capacity for accumulation or different requirement for growth of different plants. The concentration of minerals in the forage mixtures used in this experiment seems to indicate that the minerals meet the requirements of the heifers used in the experiment.

Table 7. Fortnightly body weight gain (g/d) of experimental heifers

Treatments	Initial body weight (kg)	Final body weight (kg)	1st fortnight	2nd fortnight	3rd fortnight	Overall weight gain
Hybrid sorghum+soybean (T_1)	50.075±4.86	67.880±6.60	403.67±41.11	383.34±42.40	400.00±42.49	397.22±41.48
Setaria−soybean (T_2)	49.600±2.98	66.320±5.01	364.67±21.92	379.17±21.90	375.00±14.93	376.39±18.47
Hybrid napier−soybean (T_3)	49.675±7.10	69.000±8.80	417.67±44.29	412.50±42.75	458.33±35.03	430.56±40.60
CD 5%	NS	NS	NS	NS	NS	NS

Each group was having 5 heifers.

Voluntary intake is the most important factor that determines the level and efficiency of ruminant productivity (Van soest, 1994). The DMI of the herbage mixtures in T_1, T_2 and T_3 were 3.17±0.04, 2.83±0.04 and 3.47±0.09 kg/ 100 kg body weight, respectively (table 3) and were in the range reported by Sharma and Thakur (1991) who reported that under thermoneutral conditions the DMI ranged from 2.0 to 4.0 kg/100 kg body weight. Therefore, in the present study it could be assumed that the DMI of the heifers with the different herbage mixtures were adequate to meet their requirements for growth.

The average DMI g/kg $W^{0.75}$ was significantly ($p<0.05$) higher in hybrid napier+soybean herbage mixture as compared to those of others indicating higher palatability. The lower DMI in hybrid sorghum+soybean and setaria+soybean could be due to high ADF and lignin contents (Faverdin et al., 1995) as shown in Table 1, thereby lower animal production (Table 7). The results were in agreement with those of Eroarome (2000).

The digestibility co-effiecients of the forage mixtures are a reflection of the ability of the heifers to utilize the available nutrients for growth. Hybrid napier+soybean herbage mixture had significantly ($p<0.05$) higher nutrients digestibility than other herbage mixtures (Table 4) may be due to better nutritionally desirable constituents. Pachauri and Pathak (1989) reported digestibility co-effiecients of CP, NFE, NDF and ADF as 72.1, 63.8, 63.4 and 61.5 percent; DCP and TDN as 7.31 and 57.07 percent; nitrogen balance 25.3 g/day and daily weight gain 430.0 g/day in crossbred heifers when fed on hybrid napier mixed with legume (*Leucaena leucocephala*). The digestibility co-effiecients in the present study for hybrid napier+soybean herbage mixture were comparable with the reports of Pachauri and Pathak (1989). The DCP and TDN percent in T_1, T_2 and T_3 herbage mixtures were 7.86±0.11 and 54.3± 1.27, 7.29±0.17 and 52.06±1.29 and 10.69±0.12 and 56.55±1.13, respectively (Table 5). The TDN percent in hybrid napier+soybean herbage mixture (T_3) is in agreement with those of Pachauri and Pathak (1989). The DCP and TDN intake in hybrid napier+soybean herbage mixture treatment were significantly ($p<0.05$) higher as compared to other treatments. However, the value of DCP and TDN intake were significantly ($p<0.05$) higher in hybrid sorghum+soybean (T_1) as compared to those of setaria+soybean (T_2). The nutritive value of hybrid napier+ soybean herbage mixture treatment were significantly ($p<0.05$) higher than other treatments because of higher feed intake and better nutrients utilization in animals. The variations in the nutritive value in different treatments were due to differences in feed intake and nutrient utilization in growing heifers.

The positive nitrogen balance (Table 6) in all treatments indicated that all the herbage mixtures could support not only the maintenance requirements but also modest growth rate as well of the experimental heifers. Nitrogen balance (g/d) and its utilization were significantly ($p<0.05$) higher in hybrid napier+soybean fed animals which were due to higher N intake, better utilization of N available and were correlated well with the biological performance of the heifers. The N balance in hybrid napier+soybean treatment was comparable with the reports of Pachauri and Pathak (1989).

The data (Table 7) showed higher daily body weight gain in hybrid napier+soybean treatment (430.56±40.60 g/d) as compared to hybrid sorghum+soybean (397.22±41.78 g/d) and setaria+soybean (376.39±18.47 g/d) treatments. The higher body weight gain in hybrid napier+soybean was the reflection of the herbage mixture having higher palatability, nutritive value and nitrogen balance and the results were in agreement with the reports of Pachauri and Pathak (1981).

Data obtained in this experiment demonstrated that hybrid napier+soybean herbage mixture was better than other grasses combination in humid sub-tropics of Himachal Pradesh for the nutrition of growing stock. It had the highest nutritive value, better nutrient digestibility co-efficients and consequently better animal performance in term of growth rate and feed efficiency. In ranking, hybrid napier-soybean herbage mixture was better than hybrid sorghum-soybean and setaria- soybean, while hybrid sorghum-soybean was better than setaria-soybean in nutritive value, nutrient digestibility co-efficients, growth rate and feed efficiency. For future wasteland development program in humid sub-tropics of Himachal Pradesh hybrid napier and its intercropping with legumes cultivation is recommended for consideration because of its higher nutritive value.

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