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Potential yields and nutritive values of promising forages of eastern India

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Abstract
A study was conducted to assess the potential yield and nutritive value of promising forages *viz*., multicut sorghum (var. MP Chari), annual rye, berseem (var. hybrid and wardan), oat (var. kent and JHO-822), wheat (var. VL-829) and maize hybrid. Cumulative maximum fodder yield was recorded from multicut sorghum during *kharif* season whereas, during *rabi* season, maximum forage yield was recorded from annual rye followed by berseem.Total biomass yield was recorded maximum in crops that were used for dual purposes (fodder and seed) irrespective of varieties and crops. Significantly higher dry matter intake (DMI) and crude protein digestibility (CPD) were recorded in heifers fed sole annual rye which was at par to wheat and berseem fodder. Lowest DMI and CPD were recorded in heifers fed maize or sorghum.

Keywords: Forages, Heifers, Intake, Nutritive value, Yield

Eastern region of India possesses large number of ruminant animals (162 million) which is equivalent to almost 55 million adult cattle units (GOI, 2014). Dry and green forages contribute to the tune of 80-90% in their rations; hence a total of 184 million ton dry matter is required to feed the present ruminant population. Normally green forage contribution varies from 25 to 40% in ruminant's ration depending upon the availability. But an acute shortage of green fodder prevails in the eastern part of India that varies from 82 to 89%. The main reason behind this shortage of green fodder is low landholding with negligible area under fodder production. Indeed, shortage of feed and fodder resources and neglect of feeding quality forage crops have led to decline in the productivity of Indian livestock (Ramachandra *et al.*, 2007). Feeding of green fodder not only balances the different nutrients in the rations but also useful in maintaining normal health and reproduction of ruminant animals. Majority of the farmers in eastern India follow dry forage based feeding systems with little supplementation of available concentrate feeds (Gupta *et al*., 2014). Keeping in view the above problem and paucity of information, a study was conducted to assess the potential yields and nutritive values of promising forages for eastern India.

The study was conducted at farm, ICAR Research Complex for Eastern Region, Patna during 2013-15 having tropical agro-climate, clay-loam type soil with neutral to alkaline pH. Land was prepared by adding FYM @5 t/ha and DAP @60 kg/ha. Multicut sorghum (var. MP Chari) was sown in 2,100 m^2 area during *Kharif* (rainy) season. First cut of fodder was harvested at 55 days and subsequently urea was applied @40 kg/ha as top dressing. Second cut of fodder was taken at 115 days of sowing. Fodder growth and yield related data were recorded from three sub-plots of size 100 m^2 areas each. The whole plot was left fallow for two months and again ploughed with application of FYM @5 t/ha. Total 21 sub-plots of size 100 m^2 each were prepared. Total seven fodder crops *viz*., annual rye, berseem (var. hybrid Egypt and Wardan), oat (var. Kent and JHO-822), wheat (var. VL-829) and maize (var. Shaktiman-4) were sown in sub-plots in triplicate during *Rabi* (October-November) season. All crops were irrigated just after sowing and further second irrigation was provided at 25 days of sowing and subsequently top dressing with urea @40 kg/ha in wheat crop only. Wheat crop was harvested as fodder from 50% area of 3 sub-plots at 12 cm from base height after 70 days of sowing. Irrigation was provided just after fodder harvesting with subsequent application of urea @40 kg/ha to full area of wheat sub-plots. Last irrigation was provided to all subplots of wheat at 130 days of sowing when ear head emergence was completed. Earthening up operation was followed in maize when crop attained knee height at 40 days of sowing with top dressing of urea (@40 kg/ha) and irrigation. Maize fodder was harvested on 100 days at silk formation stage. Oat fodder was harvested from all 3 sub-plots at 60 days of sowing and subsequently irrigated and provided urea @40kg/ha as top dressing. The second cut of fodder from

50% area of all 3 sub-plots of oat was taken at 105 days and remaining area was left for seed production. However, four cuts of fodder data from all sub-plots of berseem (at 50, 80, 110, 140 d) and annual rye (at 60, 80, 100, 120 d) were recorded and from 50% area of sub-plots during fifth cut (berseem 165 d and annual rye 140 d) and remaining was left for seed production. Irrigation was provided at every cutting of fodder and subsequently top dressing with urea @40 kg/ha. Dry forage and seed yield data of wheat, oat, berseem and annual rye were recorded for total biomass yield calculation. After harvesting, fodder samples were processed immediately for DM estimation and proximate principles were analysed in dried and pooled samples following the standard procedure (AOAC, 2005).

Digestibility trials were conducted in crossbred heifers (body weight: 175 ± 2.18 kg and age: 21.67 ± 1.20 months). The individual forage was provided as sole feed after chaffing in cut and carry system to three cattle heifers for 14 days as adaptation period at different time as per forage availability and subsequently digestibility trial was conducted for the period of five days. A set of another digestion trial was also conducted in six Murrah buffalo heifers (body weight: 145 ± 5.36 kg and age: 17.33 ± 0.33 months) on berseem and oat fodders only to record the comparative nutritive values of these fodders in cow and buffalo heifers. The individual animal's forage intake and faeces voided was recorded to obtain dry matter intake (DMI). Crude protein (CP) content in pooled fresh faeces was estimated for calculation of CP digestibility (CPD) and digestible crude protein (DCP) contents. Crude fibre (CF) and gross energy (GE) contents were estimated in dried forage and faeces samples for calculation of CF digestibility (CFD) and digestible energy (DE) values of different forages. Compiled data were analysed for test of significance as per standard methods of Snedecor and Cochran (1994).

Cumulative maximum fodder yield of 96.00 t/ha was recorded in multicut sorghum during rainy season (Table 1). Whereas, during winter season, maximum forage yield of 86.37 t/ha was recorded in annual rye followed by berseem. Maize forage yield was 58.67 t/ha during winter season. Average DM content was varied from 12.37 to 17.75% in different forage crops and similar type of observation was also reported earlier (Iptas and Acar, 2006). Total biomass yields from forage, straw and seeds were also studied for annual rye, berseem, oat and wheat crop (Table 2). Total biomass yields were higher in crops that were used for dual purposes (fodder and seed) irrespective of varieties and crops.

Crude protein content in cereal fodders (oat, maize and sorghum) varied from 8.65 to 11.49% on DM basis. Ibrahim *et al*. (2006) reported that DM and CP contents in maize forage were 11.88 and 8.50%, respectively. However, very high CP content (17.46%) was recorded in wheat fodder and that was almost equivalent to legume forages like berseem and annual rye, which contained 19.31 and 17.12% CP, respectively. Average DM and CP contents in forages of different varieties of berseem and oats were found comparable. Maximum CF content was

Table 1. Green fodder yield and nutrient content in forages

Fodder crops	Green fodder yield (t/ha)	DM (%)	Nutrient (% DM basis)				Gross energy (kcal/g DM)
			CP	CF	EE	TA	
Annual rye	86.37±1.42	13.99	17.12	13.97	1.38	10.91	3.94
Berseem							
Hybrid	71.10±0.10	12.37	19.27	17.00	1.23	12.37	3.84
Wardan	72.83±0.50	12.48	19.31	18.40	1.18	11.38	3.94
Oat							
Kent	27.27±0.92	16.05	11.00	19.12	1.10	8.04	3.92
JHO-822	28.33±0.55	14.77	11.49	20.90	1.14	10.66	3.90
Wheat var. VL-829	7.20±0.23	15.28	17.46	19.63	1.20	11.05	4.06
Maize var. hybrid	58.67±1.33	12.94	8.65	19.73	1.19	10.25	3.68
Sorghum var. MP Chari	96.00±2.08	17.75	8.75	29.36	1.11	8.39	3.78

Berseem sown in middle of October whereas, oat and wheat in beginning of November

Table 2. Total biomass yield performances of different crops

Fodder crops	Fodder DM yield (t/ha)	Straw yield (t/ha)	Seed yield (t/ha)	Total biomass yield (t/ha)
Annual rye				
5 cuts fodder	11.97±0.18			11.97±0.18
4 cuts fodder & seed	9.99±0.18	2.93±0.24	0.41±0.01	13.34±0.35
Berseem var. Hybrid				
5 cuts fodder	8.78±0.01			8.78±0.011
4 cuts fodder & seed	7.00±0.03	3.07±0.09	0.10±0.005	0.17±0.11
Berseem var. Wardan				
5 cuts fodder	9.11±0.06			9.11±0.06
4 cuts fodder & seed	7.10±0.08	3.57±0.09	0.30±0.01	10.96±0.14
Oat var. Kent				
2 cuts fodder	4.34±0.13			4.34±0.13
1 cut fodder & seed	2.03±0.12	4.02±0.04	1.80±0.03	7.85±0.13
Oat var. JHO-822				
2 cuts fodder	4.16±0.07			4.16±0.07
1 cut fodder & seed	1.90±0.11	3.94±0.05	1.75±0.03	7.59±0.14
Wheat var. VL-829				
1 cut fodder & seed	1.10±0.03	4.77±0.064	3.11±0.02	8.98±0.10
Seed only		.54±0.31	3.30±0.11	7.84±0.42

recorded in sorghum (29.36%), whereas it was minimum in annual rye (13.97%). Average EE and TA contents and GE values were almost similar in different forages.

Dry matter intake (DMI) and crude protein digestibility (CPD) were higher (*P<0.01*) in heifers fed annual rye exclusively, which were at par with wheat and berseem fodder (Table 3). Lowest DMI and CPD were recorded in heifers fed maize or sorghum. However, DMI in heifers was 2.91 kg/100kg body weight when fed maize fodder with concentrate feeds (Singh *et al.,* 2009). Similarly crude fibre digestibility (CFD) was low (*P<0.01*) in heifers fed maize or sorghum than other forage crops. Maximum digestible crude protein (DCP) value was obtained in berseem fodder, followed by annual rye and wheat, whereas it was minimum in maize and sorghum. Cereal forages like maize and sorghum contained more fibre and this was probably the reason for their poor nutritive value. Indeed IVDMD had negative correlation with fibre content, but it had positive association with protein content (Chaudhary *et al*., 2016). The nutritive values of maize and sorghum forage in terms of DMI, CPD and DCP were lowest; hence they need to be supplemented with legume forages for balanced feeding. It was reported that mixing of leguminous forages (15-20%) with cereal forages made them balanced in terms of nutrients to achieve optimum production from ruminant animals (Akyeampong and Dzowela, 1996; Gupta and Dey, 2015). Average intake of DCP from sole feeding of berseem and annual rye were more than 370 g/d in heifers which was more than the

Table 3. Nutritive value of different fodders

Particulars	Fodder Crops					
	Annual Rye	Berseem	Oat	Wheat	Maize	Sorghum
DMI (kg/100kg BW)	2.84^{d} ±0.11	2.71^{cd}±0.09	2.43^{bc} ±0.05	2.61^{cd} ±0.03	2.13^{ab} ±0.05	2.09^{a} ±0.07
DMD (%)	83.70^{bc} ±0.97	78.36^{b} ±1.77	84.61^{c} ±1.25	77.99^{b} ±0.59	66.60^{a} ±2.13	65.47^{a} ±0.51
CFD (%)	87.43^{c} ±0.72	79.79^{bc} ±2.88	87.12^{c} ±1.11	78.43^{b} ±0.40	65.53^{a} ±2.95	61.43^{a} ±1.87
CPD (%)	77.27^{c} ±2.25	74.01^{bc} ±1.19	65.87^{b} ±1.91	72.84^{bc} ±0.09	46.07^{a} ±3.68	43.83^{a} ±0.89
DCP (%)	13.23^{c} ±0.38	14.29^{d} ±0.23	7.57^{b} ±0.22	12.72^{c} ±0.01	3.99^{a} ±0.32	3.84^{a} ±0.08
DE (kcal/kg)	3298^{c} ±37.36	3019^{b} ±62.37	3215^{bc} ±53.07	3095^{bc} ±16.29	2414^{a} ±99.89	2382^{a} ±25.41

Values with different superscripts in a row differ significantly (P<0.01)

Table 4. Effect of fodder type and animal species on the nutritive value

Particulars	Animal		Fodder	
	Cattle	Buffalo	Berseem	Oat
DMI (kg/100 kg BW)*	2.57	2.20	2.59	2.18
DMD (%)*	81.48	75.19	75.82	80.85
CFD (%)*	83.45	71.39	70.92	83.93
CPD (%)*	69.94	60.05	71.47	58.52
DCP (%)*	10.93	9.59	13.80	6.72
DE (kcal/kg)*	3117	2845	2889	3073

* Values differ significantly (P<0.05) within groups; BW: Body weight

maintenance requirement (Ray, 1978). Berseem had higher (*P<0.05*) DMI, CPD and DCP values when compared to oat forage in cow and buffalo heifers. Again the DMI, DMD, CPD and DCP values were higher in cow heifers than buffalo (Table 4) indicating better utilization of forages in cattle. Nitrogen utilization was also better in Holstein heifer than buffalo heifer fed on similar type of rations (Gandra *et al.,* 2011).

It was concluded that berseem and/or annual rye in combination with oat is the best option for quality fodder production during *Rabi* season in eastern India, whereas it is multi cut sorghum during *Kharif* season. Nutritive value of annual rye and berseem forage was better than oat. Cereal forages like sorghum, maize and oat require supplementation of legume forages for balanced feeding in animals.

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