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Research Article

PERFORMANCE OF FODDER CROPS IN DOUBLE CROPPED RICE SUMMER FALLOWS UNDER VARYING NITROGEN REGIMES

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Abstract: The study was undertaken during summer 2017-2018 at IFSRS, Karamana with the objective of evaluating performance of different fodder crops in summer fallow of double cropped lowland rice fields under varying N regimes. The fodder crops selected for the study were fodder cowpea (CO 9), rice bean (Bidhan 2), fodder maize (African tall) and fodder sorghum (CO (FS) 31). The investigation revealed that among the different fodder crops tested, fodder maize performed better in the summer rice fallows with higher green fodder yield. However, with respect to net income it was comparable with fodder cowpea at 100 percent and 75 percent RDN. Fodder cowpea (100 and 75% RDN) recorded higher B: C ratio. Considering the shorter duration, better quality fodder and higher B: C ratio, fodder cowpea was assessed as the best fodder crop for the summer rice fallows. Yield, net income and B: C ratio of rice bean, fodder maize and fodder sorghum under varying doses of N were comparable, indicating the adequacy of 50 percent RDN.

Keywords: *Fodder crops, Nitrogen, Summer rice fallows, Fodder cowpea, Rice bean, Fodder maize, Fodder sorghum*

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Introduction

India being the world's rank first milk producer and house of highest livestock population, in contrary the area under fodder production account only 4.4 percent of total cultivated area. The annual green fodder and dry fodder requirement of the country is 1097 million tone and 609 million tone, respectively but, the total forage production is only 866 million tone. Inclusion of fodders in the diet of livestock is of prime importance as it is good source of critical elements and more economical [1]. Inadequate and unbalanced supply of feed and fodder is one of the main causes of low productivity of our livestock. The present scenario indicates the urgent need of increasing the production of fodders. Seeking the way for increasing the area under fodder production, summer rice fallows are the best option. In India, there is almost 12 million hectares of unexploited rice fallows are available [2]. In Kerala, especially in the districts of Thiruvananthapuram, Kollam and Pathanamthitta, the major rice-based cropping systems followed is rice- rice - summer fallow [3]. Introducing fodder crops in the summer rice fallows can enhance the fodder production and also sustains and improves the productivity of rice-based cropping system.

Materials and methods

The research work was carried out at the IFSRS, Karamana. The experiment was laid out in RBD with 13 treatments replicated thrice, during summer 2017-18. Four fodder crops were raised during summer 2017-18 under varying nitrogen regimes. The fertilizer recommendation of TNAU was followed for fodder cowpea, fodder maize and fodder sorghum. For rice bean as that of All India Coordinated Research for Forage Crops. The treatments were T_1 [fodder cowpea (FC) with 100 % recommended dose of nitrogen (RDN)], T_2 (FC with 75 % RDN), T_3 (FC with 50 % RDN), T_4 [rice bean (RB) with 100 % RDN], T_5 (RB with 75 % RDN), T_6 (RB with 50 % RDN), T_7 [fodder maize (FM) with 100 % RDN)], T_8 (FM with 75 % RDN), T_9 (FM with 50 % RDN), T_{10} [(fodder sorghum (FS) with 100 % RDN)], T_{11} (FS with 75 % RDN), T_{12} (FS with 50 % RDN) and T_{13} (fallow during summer).

The varieties of FC, RB, FM, FS and rice used were CO-9, Bidhan-2, African tall, CO FS-31. The leaf stem ratio was calculated at the time of harvest. The leaves and the main stem were separated from the observational plants which were uprooted without damaging. They were shade dried followed by oven drying at 60°± 5°C till the attainment of constant weight. The dry weight of leaves and stem of each plant was estimated and the ratio of leaves to stem was calculated. The green fodder yield was recorded at the time of harvest. The plants in the net plot were cut at the base and made into bundles, in each plot. The weights of green fodder were recorded and expressed as kg ha^{-1}. For calculating the dry fodder yield, the observational plants were cut at the base, separately packed and labelled. These were first shade dried and then oven dried @ 60° ± 5°C till the attainment of constant weight. The weights of these dry samples were taken and total dry fodder yield from each treatment was calculated and expressed in kg ha^{-1}. Plant crude protein content at harvest was calculated by multiplying the nitrogen content with the Simpson Factor 6.25 [4] and expressed in percentage. Plant crude fiber at harvest was calculated using AOAC method and expressed in percentage [5]. To determine the economics of cultivation, gross income, net income and benefit cost ratio were calculated based on the cost of cultivation and prevailing price of crop produce. Gross income was computed by multiplying the marketable yield of each crop with their market price and expressed as ₹ ha^{-1}. Net income was calculated using the formula, Net income (₹ ha^{-1}) = Gross income (₹ ha^{-1}) - Total cost of cultivation (₹ ha^{-1}). Cost of inputs including seeds, FYM, fertilizers and labour cost during the period of experiment were taken to calculate the cost of cultivation in rupees per hectare (₹ ha^{-1}). B: C ratio was calculated using the formula

B: C ratio = Gross returns (₹ ha^{-1}) / Cost of cultivation (₹ ha^{-1})

Results and Discussion

Quality Parameters

Among the fodder crops, T1 in fodder cowpea had significantly higher crude

protein, which was on par with T_2 in fodder cowpea and T_4 in rice bean. Crude fiber content was significantly lower in T_4 in rice bean which was on par with T1 in fodder cowpea. Crude protein content was significantly higher and crude fibre content significantly less in fodder cowpea and rice bean, especially when supplied with 100 percent RDN. Enhanced crude protein content with higher dose of N was observed by Bhavya *et al.* (2014) [6] and Balai *et al.* (2017) [7]. Baran *et al.* (1987) [8] noted a reduced crude fibre content under increased level of N application. Moreover, the application of nitrogen fertilizer significantly (P<0.01) increased the green, dry and organic matter, and crude protein yield of cowpea forage [9].

Yield Attributes and Yield

Significantly higher leaf: stem ratio was recorded in T_1 (0.90) of fodder cowpea which was on par with T_2 (0.84) and T_3 (0.75) of fodder cowpea. Among the fodder crops significantly higher leaf: stem ratio was recorded in fodder cowpea, which was on par with rice bean with 100 percent RDN. Higher leaf: stem ratio is a favourable characteristic in fodder crops, and fodder cowpea ranked first in this regard.

Table-1 Effect of treatment on crude protein and crude fibre content, percent

Treatment	Crude protein (%)	Crude fibre (%)
T_1 : Fodder cowpea with 100 % N	20.58	24.60
T_2 : Fodder cowpea with 75 % N	19.15	28.30
T_3 : Fodder cowpea with 50 % N	18.62	27.10
T_4 : Rice bean with 100 % N	19.11	23.67
T_5 : Rice bean with 75 % N	17.41	26.00
T_6 : Rice bean with 50 % N	16.84	28.00
T_7 : Fodder maize with 100 % N	9.69	33.98
T_8 : Fodder maize with 75 % N	9.38	36.70
T_9 : Fodder maize with 50 % N	8.09	38.00
T_{10} : Fodder sorghum with 100 % N	8.69	28.33
T_{11} : Fodder sorghum with 75 % N	8.37	30.33
T_{12} : Fodder sorghum with 50 % N	7.70	34.00
T_{13} : Fallow	-	-
SEm (±)	0.58	0.60
CD(0.05)	1.701	1.758

Table-2 Effect of treatments on leaf stem ratio, green fodder yield and dry fodder yield

Treatment	Leaf: stem ratio	Green fodder yield (kg ha^{-1})	Dry fodder yield (kg ha^{-1})
T_1 : Fodder cowpea with 100 % N	0.90	18417	2696
T_2 : Fodder cowpea with 75 % N	0.84	17234	2523
T_3 : Fodder cowpea with 50 % N	0.79	13864	2030
T_4 : Rice bean with 100 % N	0.68	13248	2384
T_5 : Rice bean with 75 % N	0.66	12144	2186
T_6 : Rice bean with 50 % N	0.56	12055	2170
T_7 : Fodder maize with 100 % N	0.24	29333	5177
T_8 : Fodder maize with 75 % N	0.23	28933	5107
T_9 : Fodder maize with 50 % N	0.32	31000	5471
T_{10} : Fodder sorghum with 100 % N	0.23	17383	4502
T_{11} : Fodder sorghum with 75 % N	0.22	16190	4193
T_{12} : Fodder sorghum with 50 % N	0.19	14383	3725
T_{13} : Fallow	-	-	-
SEm (±)	0.043	1540.18	271.62
CD(0.05)	0.125	4495.008	792.715

Table-3 Effect of treatments on gross income, net income and benefit: cost (B:C) ratio

Treatment	Net income (₹ ha^{-1})	B:C ratio
T_1 : Fodder cowpea with 100 % N	76066	2.44
T_2 : Fodder cowpea with 75 % N	67899	2.29
T_3 : Fodder cowpea with 50 % N	44416	1.84
T_4 : Rice bean with 100 % N	26989	1.51
T_5 : Rice bean with 75 % N	20456	1.39
T_6 : Rice bean with 50 % N	20009	1.38
T_7 : Fodder maize with 100 % N	67729	1.86
T_8 : Fodder maize with 75 % N	65860	1.84
T_9 : Fodder maize with 50 % N	76323	1.97
T_{10} : Fodder sorghum with 100 % N	33818	1.64
T_{11} : Fodder sorghum with 75 % N	22547	1.43
T_{12} : Fodder sorghum with 50 % N	19210	1.36
T_{13} : Fallow	-	-
SEm (±)	9479.859	0.126
CD(0.05)	27666.93	0.367

The green fodder yield was significantly more in T7 (29333 kg ha^{-1}) of fodder maize which was on par with T8 (28933 kg ha^{-1}) and T9 (31000 kg ha^{-1}) of fodder maize. Among the fodder crops, green fodder yield was significantly more in fodder maize irrespective of N dose. The taller stature, wider stem might have resulted in the higher yield of fodder maize. Significantly higher dry fodder yield was produced by T7 (5177 kg ha^{-1}) of fodder maize which was on par with T8 (5107 kg ha^{-1}) and T9 (5471 kg ha^{-1}) of fodder maize and T10 (4502 kg ha^{-1}) of fodder sorghum. Similar to the trend with respect to green fodder, dry fodder yield was significantly higher in fodder maize. Fodder sorghum grown with 100 percent RDN yielded equally well. This is in conformity with the findings of Chaudhary *et al.* (2018) [10] who recorded a higher yield from fodder maize owing to its taller stature, higher leaf area and wider stem diameter compared to other cereal (sorghum, pearl millet, teosinte) and leguminous fodders (lucern, fodder cowpea, cluster bean).

Economics

The net income was significantly higher in T_9 (₹ 76323 ha^{-1}) in fodder maize, which was comparable with other treatments of fodder maize [T_7 (₹ 67729 ha^{-1}), T_8 (₹ 65860 ha^{-1})] and fodder cowpea [T_1 (₹ 76066 ha^{-1}) and T_2 (₹ 67899 ha^{-1})]. In case of B:C ratio, significantly higher B:C ratio was obtained from T_1 (2.44) and T_2 (2.29) of fodder cowpea, which were on par. Net income was significantly higher from fodder maize, irrespective of the N dose and was on par with fodder cowpea grown with 100 and 75 percent RDN, when compared to other fodder crops. The higher yield obtained from fodder maize and fodder cowpea generated more returns and hence, greater net income. However, significantly higher B:C ratio was recorded in fodder cowpea grown with 100 and 75 percent RDN. Though the net income from fodder maize was on par with fodder cowpea, the lower cost of cultivation for fodder cowpea resulted in the higher B:C ratio. Fodder maize requires more organic manure (25 t ha^{-1}) compared to fodder cowpea (12.5 t ha^{-1}), which is a prime factor contributing to the difference in cost of cultivation. Moreover, fodder cowpea being a leguminous fodder, has a higher crude protein and fetches a higher price per kilogram *i.e.* ₹ 7 kg^{-1}, while for fodder maize it is only ₹ 5 kg^{-1}.

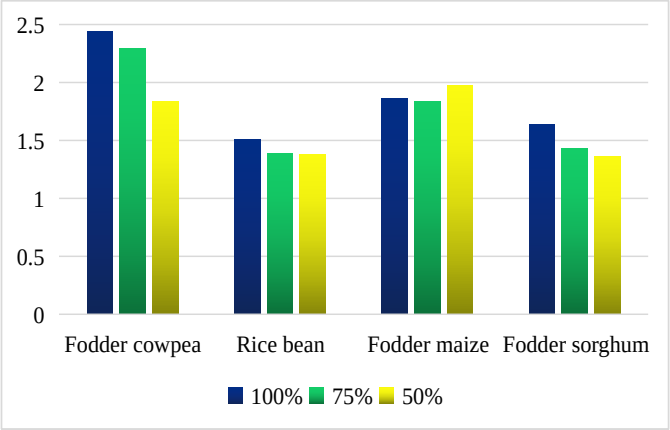

Fig-1 Effects of treatments on B: C ratio of fodder cultivation

Conclusion

Among the different fodder crops, fodder cowpea performed better in summer fallows specially with 100 and 75 per cent RDN.

Application of research: Nitrogenous fertilizers are often lost through leaching or volatilization. Moreover, the summer fallow has residual nitrogen through the applied fertilizers and decomposition of rice stubbles. The study shows that, among the four different fodder crops, a higher yield of fodder cowpea can be obtained with application of 75% recommended dose of nitrogen.

Research Category: Agronomy

Abbreviations: B: C ratio- Benefit cost ratio, CD- Critical Difference, FC- Fodder Cowpea, FM- Fodder Maize, FS- Fodder Sorghum, IFSRS- integrated farming system research station, N- nitrogen,

RB- Rice bean, RBD-Randomized Block Design
RDN- Recommended Dose of Nitrogen, SEm- Standard Error of Mean

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Study area / Sample Collection: IFSRS, Karamana

Cultivar / Variety / Breed name: Fodder cowpea (CO 9) , Rice bean (Bidhan 2), Fodder maize (African tall), Fodder sorghum (CO (FS) 31)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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