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Proximate Composition Assessment of Fodder Maize with Ricebean Intercropping under Different Nutrient Management Practices

RUNDAN V.[1,2], MAGAN SINGH[2*], PRAVEEN B.R.[2] AND M. BHARGAVA NARASIMHA YADAV[3] AND CHETHAN BABU R.T.[2]

[1]Department of Agronomy, [3]Department of Soil Science and Agricultural chemistry, University of Agricultural Sciences, Dharwad-580005, India

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ABSTRACT

Fodder cereals and legume-based intercropping play an important role in providing a balanced diet to our livestock. Legumes in fodder cereals have the potential to improve forage quality and quantity. Furthermore, nutrient management practices in forage legume-based intercropping play a significant role in minimizing the dose of fertilizer required. Therefore, the present investigation to study the effect of nutrient management practices on fodder maize and ricebean intercropping under additive series was conducted during the rainy season of 2019 at the Research Farm of Agronomy Section, ICAR-NDRI, Karnal. The experimental result revealed a higher value of green fodder and dry matter yield in a 1:1 and 2:1 ratio of maize + ricebean intercropping with 100% RDF and PGPR. Among the various proximate analyses, higher values of crude protein, ether extract and total ash content were associated with lower fiber fractions viz., NDF, ADF and ADL value analyzed in sole crops receiving 100% RDF. Furthermore, the intercropping 1:1 ratio receiving 75-100 percent RDF with PGPR was found to be suitable for higher yields with improved fodder quality. Seed treatment with PGPR in fodder cereal and legume-based intercropping has the potential to decrease the fertilizer demand by 25 per cent without compromising fodder yield and quality.

Key words: Biofertilizers, Correlation, Fodder quality, Intercropping, PGPR, Yield

INTRODUCTION

Fodder-based intercropping is gaining importance in the present scenario due to the increase in the cost of feeds, which comprise 60–70 per cent of milk production (Shawbkeh *et al.,* 2011). Quality fodder plays a crucial role in reducing the cost and helping to maintain sustainability in livestock production (Kumar *et al.,* 2023a). Inclusion of legumes in fodder cereals helps to enhance the fodder quality by increasing protein and mineral content while lowering the indigestible fiber fractions in fodder crops, as most of the fodder cereals are genetically low in protein content (Ibram *et al.,* 2006). Growing more than two crops in the same field at the same time as intercropping helps in better utilization of available nutrients, reduces nutrient leaching and increases nutrient cycling, through a complementary effect (Pandey and Singh, 2018). Studies have reported that intercropping of legumes with fodder cereals helps to supplement the protein requirements by increasing the forage intake and digestibility (Javamard *et al.,* 2009). Intercropping of legumes with fodder cereals helps to supply balanced minerals to the dairy animals, as legume fodder is superior in its accumulation of minerals such as Ca, Mg, Cu, Zn, Mn and Co in comparison with cereal fodder (Juknevicius and Sabiene, 2007). In addition to quality, quantity of fodder is critical. Due to an increase in population pressure, per capita land availability has been on a downward trend over the past few decades and most of the cultivated land is utilized for the production of food crops, which creates challenges for the expansion of area under fodder crops (Seran and Brintha, 2010). To meet the present demand for green fodder it must be grown at 1.69 per cent annually (Anonymous, 2016). These challenges can be overcome by increasing productivity per unit area through improved practices such as nutrient management, crop rotation, crop diversification and using PGPR etc. PGPR is a consortium of bacteria that actively colonize around plant roots and enhances plant growth and yield (Kumar *et al.,* 2023b). The beneficial effects of PGPR due to their ability to produce various organic compounds *viz*., auxins, gibberellins, cytokinin, ethylene, organic acids and siderophores; nitrogen fixation, solubilization of insoluble

[2]*Agronomy Section, ICAR-National Dairy Research Institute, Karnal-132001, India*
**Corresponding author email: magansingh07@gmail.com*

inorganic soil phosphate to available form, increases root permeability as well as enhancement of essential plant nutrients uptake (Kumar *et al.,* 2022).

Maize (*Zea mays* L.) is the most important *kharif* fodder, which is grown over 0.9 m ha in various parts of the country due to its high yielding potential, good quality and absence of anti-nutritional factors, making it the most preferred fodder crop among the farming community (Tamta *et al.,* 2019). Ricebean [*Vigna umbellate* (Thub.)] is one of the underutilized leguminous fodder crops, which is grown in the eastern, western and northern parts of our country with an average cultivated area of 20,000 ha. It is a neglected crop that can be grown under diverse climatic conditions, from tropical to temperate, with no additional inputs (Arora *et al.,* 1980). Ricebean botanically has an erect to semi-erect growth habit, but some varieties have twining characteristics that make them most suitable for growing with fodder maize. On average, ricebean forage contains 21.3 percent of crude protein, 12.3 per cent of total ash and 29.5 per cent of crude fiber (Ayub *et al.,* 2004). Maize and ricebean are important fodder crops grown by farmers primarily as a sole crop, the ricebean crop, in particular, has been neglected and underutilized by the farming community. Since most of the traditional ricebean varieties produce good biomass but low seed yields, Henceforth, considerable efforts need to be made to use local ricebean varieties as fodder crops in prominent fodder maize cropping systems through proper ratios with suitable nutrient management practices including the use of PGPR for improving both the quality and quantity of cereal fodder. Keeping in view of all these facts, the study was undertaken to determine the effect of nutrient management practices on fodder maize and ricebean intercropping in irrigated conditions.

MATERIALS AND METHODS

Agronomic experiment was performed at Research Farm of Agronomy Section, ICAR-NDRI, Karnal during *Rainy* season of 2019. Geographically, the experimental site situated at 29°45' N latitude, 76°58' E longitude and at an altitude of 245 m above mean sea level (MSL). The soil of an experimental site was neutral in pH (7.24), clay loam in texture, medium in organic carbon (0.62%), low in available N (147.4 kg/ha) and medium in available P (24.5 kg/ha) and K (251.2 kg/ha).The experiment was laid out in Randomized Block Design (RBD) with 14 treatments *viz*., T_{1} = Maize sole + RDF; T_{2} = Ricebean sole + RDF; T_{3} = Maize + Ricebean (1:1) + RDF; T_{4} = Maize + Ricebean (1:1) + 50% RDF; T_{5} = Maize + Ricebean (1:1) +50% RDF + PGPR; T_{6} = Maize + Ricebean (1:1) + 75% RDF; T_{7} = Maize + Ricebean (1:1) + 75% RDF + PGPR; T_{8} = Maize + Ricebean (1:1) + 100% RDF + PGPR; T_{9} = Maize + Ricebean (2:1) + RDF; T_{10} = Maize + Ricebean (2:1) + 50% RDF; T_{11} = Maize + Ricebean (2:1) + 50% RDF + PGPR; T_{12} = Maize + Ricebean (2:1) + 75% RDF; T_{13} = Maize + Ricebean (2:1) + 75% RDF + PGPR and T_{14} = Maize + Ricebean (2:1) + 100% RDF + PGPR and replicated thrice. The recommended dose of fertilizer for maize i.e., 120:60:40 kg NPK/ha and ricebean i.e., 20:50:20 kg NPK/ha. For sole crops their respective recommended dose of fertilizer was applied whereas, in intercropping we consider the demand of only main crop (maize) and fertilizer varied as per the treatments (100%, 75% and 50% RDF). The fodder maize (Cultivar J-1006) and ricebean (Sikkim local) were sown with seed rate of 45 and 35 kg/ha during 1st week of August by giving spacing of 30 × 10 cm for sole crop of maize and ricebean. Whereas, intercropped maize geometry was modified by giving spacing of 45 × 7.5 cm to introduce ricebean. For accommodating component crops in intercropping treatments additive series was used.

Forage crops were harvested manually by separating maize and ricebean to determine extra fodder yield obtained from each treatment at 60 DAS. The collected samples were dried in a hot air oven (70°C) and grinded with help of Willey mill to pass through a 2 mm sieve for further analysis. Further processed samples were analyzed for estimation of dry matter, ether extract, total ash and crude protein estimated by Kjeldahl method (AOAC, 2005) and multiplied by 6.25. Fiber fraction such as Neutral detergent fiber was estimated by the procedure suggested by Van Soest *et al*. (1991). Acid detergent fiber was analyzed according to AOAC, 2005. Total digestible nutrients (TDN), digestible dry matter (DDM), dry matter intake (DMI), relative feed value (RFV) and net energy for lactation (NE_l) were estimated as per the equations adapted from Horrocks and Vallentine (1999). The equations are TDN = (-1.291 × ADF) + 101.35; DMI = 120 / %NDF dry weight basis; DDM = 88.9 – (0.779 × % ADF, dry weight basis); RFV = %DDM × %DMI × 0.775; NE_l = (1.044 – (0.0119 × % ADF)) × 2.205. The data which has been collected during the field experiment were analyzed using analysis of variance (ANOVA) as described by Gomez and Gomez (1984) in MS EXCEL. The statistical significance of the experimental data was determined using 'F' test at 5% level of significance and critical difference (P=0.05) values were calculated whenever the F test was found significant.

RESULTS AND DISCUSSION

Forage Yield (GFY & DMY)

The fodder yield is directly related to the genetic potential of a particular variety. Along with a variety, some agronomic interventions adopted during crop production, especially nutrient management practices play a significant role in the accumulation of fodder yield. Dry matter and green fodder yields differ significantly ($P<0.05$) under the influence of different nutrient management practices which are presented in Table 1. Green fodder and dry matter yield of both the base crop, *i.e.*, maize (34.17 and 8.51 t/ha) and ricebean (15.17 and 3.57 t/ha) were relatively higher in sole crops with RDF in comparison with intercropping conditions. But maize performs better in 1:1 and 2:1 row proportion, receiving up to 75–100 per cent RDF with PGPR. This is due to the partitioning of available resources among both crops under intercropped cultivation. However, the total green and dry matter yield was found to be superior in intercropped conditions, especially by sowing maize and ricebean in a 1:1 ratio with RDF and PGPR (45.25 and 10.93 t/ha), this treatment being comparable with the intercropped ratios of 1:1 and 2:1, receiving 75–100 per cent RDF with PGPR. This is due to the fact that more photosynthetic area per unit area leads to better utilization of available resources such as light, water and nutrients, which in turn increases biomass production. The extra yield contribution from ricebean in the 1:1 additive series eventually increases the fodder yield. Further increases in fertilizer dose have a positive effect on other growth attributes which are directly related with green fodder yield. The results are in tune with Zaman and Malik (2000) and Kheroar and Patra (2013).

Table 1: Effect of nutrient management and row pattern on Yield of fodder crops

Treatments	Green fodder yield (t/ha)			Dry matter yield (t/ha)		
	M	R	Total	M	R	Total
Maize + RDF	34.17^{a}		34.17^{e}	8.51^{a}	-	8.51^{d-g}
Ricebean + RDF	-	15.17^{a}	15.17^{f}		3.57^{a}	3.57^{h}
M + R (1:1) + RDF	31.07^{a-c}	13.02^{b}	44.08^{ab}	7.5^{a-c}	3.01^{b}	10.5^{ab}
M + R (1:1) + 50 %RDF	26.40^{d}	10.10^{c}	36.50^{de}	5.84^{e}	2.06^{cd}	7.90^{g}
M + R (1:1) + 50 %RDF + PGPR	27.62^{b-d}	10.05^{c}	37.67^{c-e}	6.22^{de}	2.150^{c}	8.37^{e-g}
M + R (1:1) + 75% RDF	30.17^{a-d}	12.00^{b}	42.17^{a-c}	6.87^{b-e}	2.74^{b}	9.61^{b-e}
M + R (1:1) + 75% RDF + PGPR	29.67^{a-d}	12.52^{b}	42.00^{a-c}	6.81^{b-e}	2.88^{b}	9.69^{a-d}
M + R (1:1) + 100% RDF + PGPR	32.00^{ab}	13.25^{b}	45.25^{a}	7.85^{ab}	3.07^{b}	10.93^{a}
M + R (2:1) + RDF	32.08^{ab}	8.25^{cd}	40.33^{b-d}	7.78^{ab}	1.92^{cd}	9.7^{a-d}
M + R (2:1) + 50 %RDF	27.00^{cd}	7.33^{d}	34.33^{e}	5.95^{e}	1.67^{d}	7.61^{g}
M + R (2:1) + 50 %RDF + PGPR	27.83^{b-d}	7.17^{d}	35.00^{e}	6.34^{c-e}	1.64^{d}	7.98^{fg}
M + R (2:1) + 75% RDF	31.15^{a-c}	7.48^{d}	38.63^{c-e}	7.41^{a-d}	1.74^{cd}	9.15^{c-f}
M + R (2:1) + 75% RDF + PGPR	31.20^{a-c}	7.47^{d}	38.67^{c-e}	7.51^{a-c}	1.72^{cd}	9.23^{c-e}
M + R (2:1) + 100% RDF + PGPR	31.92^{ab}	8.58^{cd}	40.50^{b-d}	7.95^{ab}	1.99^{cd}	9.94^{a-c}
SEm±	1.34	0.62	1.41	0.37	0.14	0.39

Note: Means followed by the same letter (s) did not differ significantly by DMRT (p= 0.05)
M- Maize; R- Ricebean; RDF- Recommended dose of fertilizer; PGPR- Plant growth promoting rhizobacteria;

Dry Matter (DM%) and Crude Protein (CP%)

Dry matter is an essential component that helps to determine the amount of moisture present in fodder. It also reflects the quality of fodder as most of the nutrient content in fodder is determined using dry matter yield. In maize higher value of dry matter percentage was

Table 2: Effect of nutrient management and row pattern on quality parameters of fodder crops

Treatments	DM (%)		CP (%)		EE (%)		TA (%)		NDF (%)		ADF (%)		ADL (%)	
	M	R	M	R	M	R	M	R	M	R	M	R	M	R
Maize + RDF	24.89^{a}	-	8.94^{a}	-	1.99^{a}	-	7.41^{a}	-	60.17^{a}	-	34.23^{a}	-	4.81^{a}	-
Ricebean + RDF	-	23.53^{a}	-	18.93^{a}	-	1.80^{a}	-	10.92^{a}	-	53.03^{a}	-	37.27^{a}	-	7.57^{c}
M + R (1:1) + RDF	24.10^{a-d}	23.17^{ab}	8.73^{ab}	18.07^{a-c}	1.89^{ab}	1.60^{b-d}	7.23^{a-c}	10.55^{a-c}	61.40^{a}	54.05^{a}	35.06^{a}	37.97^{a}	5.09^{a}	8.10^{a-c}
M + R (1:1) + 50 %RDF	22.17^{cd}	20.41^{c}	7.63^{c}	17.00^{c}	1.51^{b}	1.40^{f}	7.00^{c}	9.64^{c}	63.77^{a}	55.87^{a}	36.73^{a}	39.86^{a}	5.63^{a}	8.75^{a}
M + R (1:1) + 50 %RDF + PGPR	22.56^{b-d}	21.42^{bc}	7.92^{bc}	17.13^{bc}	1.52^{b}	1.42^{f}	7.02^{c}	9.71^{bc}	63.59^{a}	55.73^{a}	36.37^{a}	39.51^{a}	5.74^{a}	8.70^{ab}
M + R (1:1) + 75% RDF	22.79^{a-d}	22.87^{ab}	8.4^{a-c}	17.53^{bc}	1.62^{ab}	1.45^{ef}	7.10^{a-c}	10.32^{a-c}	62.23^{a}	54.67^{a}	35.46^{a}	38.73^{a}	5.19^{a}	8.53^{ab}
M + R (1:1) + 75% RDF + PGPR	22.96^{a-d}	22.97^{ab}	8.53^{ab}	17.57^{bc}	1.73^{ab}	1.49^{d-f}	7.07^{bc}	10.42^{a-c}	61.80^{a}	54.13^{a}	35.64^{a}	38.21^{a}	5.19^{a}	8.43^{ab}
M + R (1:1) + 100% RDF + PGPR	24.60^{ab}	23.22^{ab}	8.77^{ab}	18.10^{a-c}	1.92^{a}	1.61^{bc}	7.31^{a-c}	10.77^{ab}	60.77^{a}	53.87^{a}	34.84^{a}	37.94^{a}	4.97^{a}	8.00^{a-c}
M + R (2:1) + RDF	24.30^{a-c}	23.27^{ab}	8.79^{ab}	18.24^{a-c}	1.93^{a}	1.70^{ab}	7.27^{a-c}	10.80^{a}	61.01^{a}	53.40^{a}	34.80^{a}	37.75^{a}	4.90^{a}	8.03^{a-c}
M + R (2:1) + 50 %RDF	22.06^{d}	22.73^{ab}	8.00^{bc}	17.30^{bc}	1.58^{ab}	1.43^{f}	7.00^{c}	9.92^{a-c}	63.00^{a}	55.15^{a}	36.50^{a}	39.28^{a}	5.27^{a}	8.67^{ab}
M + R (2:1) + 50 %RDF + PGPR	22.68^{a-d}	22.83^{ab}	8.03^{bc}	17.33^{bc}	1.60^{ab}	1.44^{f}	7.03^{c}	10.09^{a-c}	62.26^{a}	55.69^{a}	36.60^{a}	38.77^{a}	5.23^{a}	8.62^{ab}
M + R (2:1) + 75% RDF	23.77^{a-d}	23.07^{ab}	8.64^{ab}	17.80^{a-c}	1.77^{ab}	1.56^{c-e}	7.20^{a-c}	10.12^{a-c}	61.56^{a}	54.24^{a}	35.41^{a}	38.03^{a}	5.11^{a}	8.34^{a-c}
M + R (2:1) + 75% RDF + PGPR	24.10^{a-d}	23.06^{ab}	8.68^{ab}	17.95^{a-c}	1.80^{ab}	1.57^{cd}	7.21^{a-c}	10.15^{a-c}	61.53^{a}	54.13^{a}	35.13^{a}	37.96^{a}	5.10^{a}	8.20^{a-c}
M + R (2:1) + 100% RDF + PGPR	24.87^{a}	23.21^{ab}	8.83^{ab}	18.27^{ab}	1.96^{a}	1.73^{a}	7.38^{ab}	10.83^{a}	60.43^{a}	53.24^{a}	34.56^{a}	37.54^{a}	4.83^{a}	7.90^{bc}
SEm±	0.67	0.59	0.28	0.34	0.09	0.04	0.09	0.29	1.89	0.86	1.24	1.17	0.28	0.24

M- Maize; R- Ricebean; RDF- Recommended dose of fertilizer; PGPR- Plant growth promoting rhizobacteria; DM: Dry matter; CP: Crude protein; EE: Ether extract; TA: Total ash; NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin noticed in sole maize (24.89%) which receives 100% RDF, but it was statistically at par with T_3, T_6, T_7, T_8, T_9, T_{11}, T_{12}, T_{13} and T_{14} intercropped treatments (Table 2). In ricebean greater value of dry matter percentage was recorded in the sole ricebean (23.53%) with RDF. However, all intercropped treatments except T_4 and T_5 treatments recorded statistically identical values in comparison to sole ricebean. Maize and ricebean witnessed higher dry matter content in sole crop due to higher nutrient uptake with RDF and zero competition with intercrop cultivation. But under the intercropped conditions both the crop experienced inter-specific competition and less nutrient uptake by both main and intercrop led to lower contribution towards dry matter accumulation. However, the findings were contradictory with Eskandari (2012). Protein plays a most crucial role in all living organisms which act as a building block of plant tissues. It is a vital component of an animal diet. Most of the prices of feed and fodder are fixed based on protein content. Higher crude protein percentage was analyzed in sole crop [maize (8.94%) and ricebean (18.93%)] with RDF. Among the intercropping maize sown in 1:1 and 2:1 with ricebean with appication of 75-100 percent RDF with PGPR seed treatment was found to be statically onpar with sole maize. But in terms of total crude protein yield greater value was recorded in the plot where Maize + Ricebean sown in 1:1 ratio with 100% RDF and PGPR (12.44 t/ha) which is almost double the crude protein yield in comparison to sole cultivation of maize and ricebean. whereas, a lower value was noticed in sole ricebean + RDF (Fig 1). Even though protein content of both maize and ricebean was found to be higher than intercrop, but total crude protein yield was lower in compare to intercrop treatments this might be due to extra protein yield from ricebean which was almost 38.7% and 45.8% more in comparison sole maize and ricebean plot with T_8 treatment and Application of 75-100 percent of recommended dose of fertilizer under intercropped cultivation led to higher uptake. A higher supply of nitrogen along with phosphorous and potassium result in higher protein synthesis and role potassium in activation nitrate reductase enzyme helps in good uptake of nitrogen which reflects the protein content in fodder crop. A similar trend was also noticed by Ibrahim *et al*. (2012).

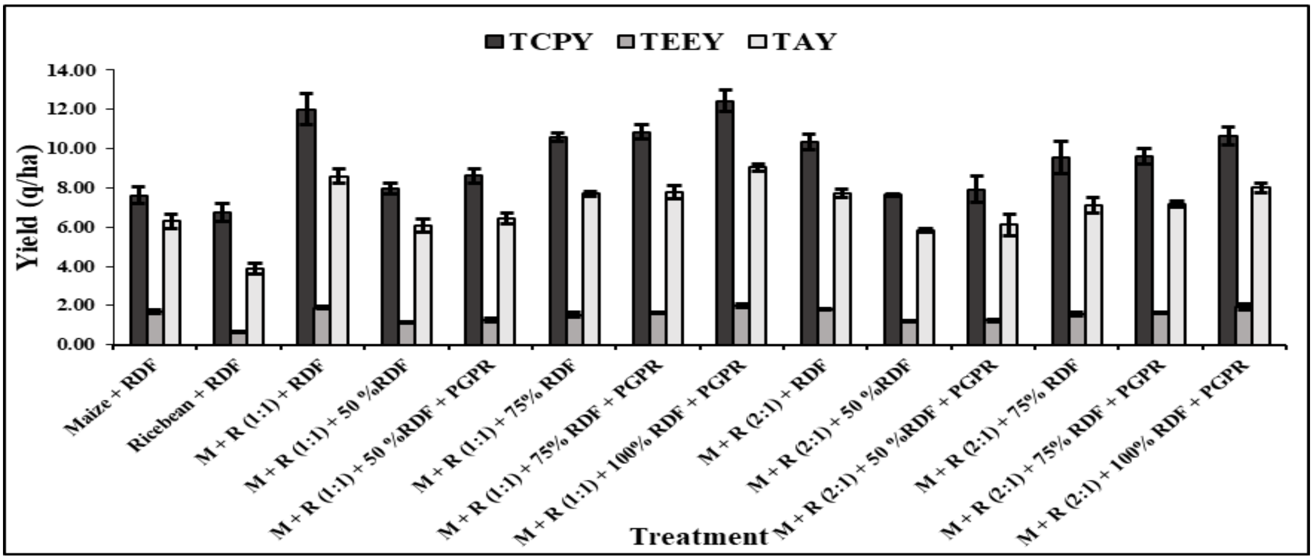

Fig 1: Influence of nutrient management and row ratio on Total Crude Protein Yield (TCPY), Total Ether Extract yield (TEEY), Total Ash yield (TAY) of fodder crops

Ether Extract (EE) and Total Ash (TA)

Ether extract and total ash showed a significant difference ($P<0.05$) among different treatments (Table 2). Maximum ether content was observed in sole crops with RDF but ether yield was higher in T_8 (maize + ricebean (1:1) + 100% RDF + PGPR). Further the 1:1 and 2:1 with RDF and PGPR also recorded statistically similar ether to T_8 treatment and lower value in sole ricebean + RDF (Fig 1). The increase ether content of maize and ricebean due to fertilizer dose could be attributed to a decrease in plant lignin and fibre content. Similar observations were also recorded by Ibrahim *et al*. (2012). In fodder, ash represents the mineral content of the plant. A critical analysis of data regarding total ash content in fodder maize and ricebean showed a significant difference (P<0.05) of higher mineral contents noticed in sole maize and ricebean with RDF. Total ash content is maize follow the similar trend as ether content in intercropped maize, some of the intercrop performed similar to the base crop in terms of toatal ash content. This might be due to the synergetic effect of fodder ricebean through fixation of nitrogen from atmosphere and supplement to main crop through its legume effect. However, total ash yield was significantly varied and found to be higher under intercropping conditions, *i.e.*, sowing maize + ricebean (1:1) + 100% RDF + PGPR and lower ash yield recorded in sole ricebean respectively (Fig 1). The increasing trend of total ash yield with an increase dose of nutrients might be due to more uptake of minerals from soil, which in turn increase the dry matter content and yield as there is a positive interaction of N, P and K fertilizers with some micronutrients. The results are in agreement with Ayub *et al*. (2004).

Fibre fractions and its constituents

The fiber fraction such as NDF, ADF and ADL was not significantly (P>0.05) influenced by different nutrient management practices (Table 2). The highest value of fibre fraction (NDF, ADF and ADL) reported in maize + ricebean (1:1) + 50% RDF in both maize and ricebean and, the least was recorded in sole maize and ricebean with RDF. The lower value of NDF, ADF and ADL in the fodder crop represents better fodder quality. However, in ricebean, only ADL showed a statistically significant difference (P<0.05) among various treatments, and lower lignin content was recorded in sole ricebean + RDF, which showed better quality. The higher fiber fraction in 1:1 ratio with 50% RDF may be due to competition for available nutrients, however, they statistically did not differ from sole plot value due to more nodulation in ricebean with nitrogen scarcity, which aids in partial fulfilment of nitrogen demand under intercropped conditions. Lower value in the sole crop may be due the more succulent fodder with an increased dose of nitrogen.

Table 3: Effect of nutrient management and row pattern on quality parameters of fodder crops

Treatments	TDN (%)		DMI (%)		DDM (%)		RFV (%)		NE_l (MJ/kg)	
	M	R	M	R	M	R	M	R	M	R
Maize + RDF	57.15	-	1.99	-	62.23	-	96.19	-	1.40	-
Ricebean + RDF	-	53.24	-	2.26	-	59.87	-	105.08	-	1.32
M + R (1:1) + RDF	56.09	52.34	1.96	2.22	61.59	59.32	93.68	102.09	1.38	1.31
M + R (1:1) + 50 %RDF	53.93	49.90	1.89	2.15	60.28	57.85	88.23	96.41	1.34	1.26
M + R (1:1) + 50 %RDF + PGPR	54.40	50.34	1.89	2.15	60.57	58.12	88.63	96.96	1.35	1.27
M + R (1:1) + 75% RDF	55.57	51.35	1.93	2.20	61.28	58.73	91.58	99.88	1.37	1.29
M + R (1:1) + 75% RDF + PGPR	55.34	52.02	1.94	2.22	61.14	59.13	92.18	101.64	1.37	1.30
M + R (1:1) + 100% RDF + PGPR	56.37	52.37	1.97	2.23	61.76	59.34	94.56	102.46	1.39	1.31
M + R (2:1) + RDF	56.42	52.61	1.98	2.25	61.79	59.49	94.48	103.65	1.39	1.31
M + R (2:1) + 50 %RDF	54.23	50.64	1.91	2.18	60.47	58.30	89.35	98.40	1.34	1.27
M + R (2:1) + 50 %RDF + PGPR	54.10	51.30	1.93	2.16	60.39	58.70	90.27	98.07	1.34	1.28
M + R (2:1) + 75% RDF	55.64	52.25	1.96	2.21	61.32	59.27	93.17	101.63	1.37	1.30
M + R (2:1) + 75% RDF + PGPR	56.00	52.35	1.95	2.22	61.54	59.33	93.09	102.12	1.38	1.31
M + R (2:1) + 100% RDF + PGPR	56.73	52.89	1.99	2.26	61.98	59.66	95.41	104.25	1.40	1.32
SEm±	1.61	1.51	0.06	0.03	0.97	0.91	3.17	1.93	0.03	0.03

M- Maize; R- Ricebean; RDF- Recommended dose of fertilizer; PGPR- Plant growth promoting rhizobacteria; TDN: Total Digestible Nutrient; DMI: Dry Matter Intake; DDM: Digestible Dry Matter; RFV: Relative Feed Value; NE_l: Net Energy for Lactation

TDN, DMI, DDM, RFV and NE_l

Data pertaining to TDN, DMI, DDM, RFV and NE_1 content are presented in (Table 3). There was no significant difference (P>0.05) recorded among the various treatments by nutrient management practices in both maize and ricebean. However, maximum value of TDN, DMI, DDM, RFV and NE_1 has been observed in sole crop plots, with the least value in the plot where maize + ricebean sown in a 1:1 ratio with 50% RDF.

Table 4: Correlation studies among different fodder quality parameters

Pearson Correlation									
Attributes	DM	CP	EE	TA	TDN	DMI	DMD	RFV	NE_l
DM	1	.909**	.961**	.985**	.939**	.927**	.939**	.953**	.940**
CP		1	.940**	.895**	.964**	.942**	.965**	.976**	.940**
EE			1	.955**	.941**	.964**	.941**	.976**	.934**
TA				1	.947**	.931**	.947**	.952**	.947**
TDN					1	.916**	1.000**	.967**	.992**
DMI						1	.916**	.984**	.899**
DMD							1	.967**	.992**
RFV								1	.954**
NE_l									1

***Correlation is significant at the 0.01 level (2-tailed)*

Correlation studies

Studies of various quality enhancing parameters was highly correlated (significant at the 0.01level) with one other and with (Table 4.).

From the findings of the research, it concludes that the combined application of 75 – 100 percent RDF and PGPR in maize + ricebean 1:1 or 2:1 intercropping significantly increased the fodder yield and also enhanced the quality parameters, which eventually indicated the fulfilment of qualitative fodder production. In comparisons with 1:1 and 2:1 ratio, sowing maize and ricebean in 1:1 was found to best in terms of augmenting biomass with quality fodder production and use of PGPR in fodder cereal and legume-based intercropping has a potential to decrease the fertilizer demand by 25 per cent without compromising fodder yield. Studies can further be conducted to utilize additive series during delayed sowing (beyond July) due to abnormal weather as there is a chance of decreasing fodder yield in maize due to a decrease in day length. Furthermore, ricebean is an option that most of the studies suggested delayed sowing of ricebean can be extended till August, which has the potential to grow luxuriously with maize and help to compensate the yield loses along with enhancing the fodder quality.

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