RESIDUAL EFFECT OF FODDERS ON THE SUCCEEDING RICE CROP

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ABSTRACT

In the rice- rice- summer rice fallow cropping system, four different fodder crops were raised in the summer under varying nitrogen regimes with the primary objective of assessing its residual effect on the growth and yield of first crop of rice, 2018-19. The experiment was laid out in Randomized Block Design with three replications. The control treatment was fallow during summer. The fodder crops were fodder cowpea (CO- 9), rice bean (Bidhan- 2), fodder maize (African tall), fodder sorghum (CO (FS) 31). The varying nitrogen regimes were 100, 75 and 50 per cent recommended dose of nitrogen (RDN). With respect to growth and yield of the rice crop, plant height alone exhibited a significant difference between the treatments at 20 and 40 DAS and at harvest. But, there was no specific pattern in the observed differences in plant height with regard to the preceding fodder crops or varying doses of nitrogen. All the growth and yield attributes, net income and B: C ratio was observed to be unaffected by the preceding summer fodder crops. Further, reducing the RDN for the summer crops did not have any adverse effect on the productivity and economics of the succeeding rice crop.

KEYWORDS: *Residual Effect, Rice, Fodder Crops, Fodder Cowpea, Rice Bean, Fodder Maize, Fodder Sorghum, Nitrogen, Summer Rice Fallow*

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INTRODUCTION

The rice based cropping system is a potential platform for residual or carry over effects of one crop to act up on the succeeding ones. In Southern Kerala the major rice based system followed is rice-rice-summer fallow (John *et al.*, 2014). Judicious integration of fodder crops in the summer rice fallows increases the fodder availability along with enhanced system productivity. In addition to that, the incorporated rice stubble offers a chance to reduce application of chemical fertilizers specially the nitrogenous fertilizers, where nitrogen concentration in the rice straw alone ranges from 0.4 to 0.7 on dry weight basis (Williams *et al.*, 1968). It is to be noted that, 75% of anthropogenic nitrogen source comes under the leached agricultural inputs, i.e. fertilizers and manures (Mosier *et al.*, 1996). Further, the legume effect in rice based cropping system enhanced the grain yield of rice, which is often accomplished through increased plant height, increased productive tillers, tiller number or straw yields (Mridha, 1987). However, the decline in the yield of rice in the rice based cropping system can be due the exhaustive nature of cereals included in the system (Jadhav, 1989). Rice subsequent to forage legumes recorded a yield increase of 0.6 to 2.4 t ha⁻¹ (Carangal *et al.* 1994; Ladha *et al.* 1996). The wider C: N ratio of sorghum and Sudan grass reduced the availability of N to the subsequent crops despite the accumulated N in the crop residues long considerable (Sattell *et al.*, 1998). Ramachandra *et al.* (2007) observed that the average yield of rice or fodder maize in sequence declined, whereas more or less equal yield was obtained for rice succeeding legumes. Toaima *et al.* (2014) reported that Sudan grass had positive allelopathic effect on the subsequent crops of berseem, faba bean

and onion on forage yield, seed yield and bulb yield respectively. But the yield of fodder beet, wheat and sugar beet declined when grown after Sudan grass and sorghum compared to the fallow treatments.

Considering all these factors, the study was undertaken to assess the residual effect of fodder crops under varying regimes of nitrogen on the growth and yield of succeeding rice crop.

MATERIALS AND METHODS

In the experiment, fodder crops were raised during the period of summer 2018 (February 21st to 11th May) and the succeeding *virippu* rice crop (var. Uma) was taken up during 11th June – 26th October, 2018. The site of experiment was double cropped low land rice fields of Integrated Farming System Research Station of Kerala Agricultural University located at Karamana, Thiruvananthapuram. The study on residual effect was concentrated only in *virippu* rice crop, where minimum temperature during the period ranged from 20.07 to 24.64°C and the maximum temperature varied from 28.28 to 32.21 °C. The relative humidity of the area ranged from 75.07 to 93.85 per cent. The total rain fall received during the *virippu* season was 898.48 mm. The soil in the site of experiment was sandy clay loam in texture, moderately acidic with normal electric conductivity, medium in OC, available N, P and K.

The experiment was laid out in Randomized Block Design with thirteen treatments. In the summer fallow, four fodder crops *viz.*, fodder cowpea (FC), rice bean (RB), fodder maize (FM) and fodder sorghum (FS) were raised under three levels of nitrogen *viz.*, 100 % RDN, 75% RDN and 50% RDN. Rice var. Uma raised in the *virippu* season. The treatments were T₁: Rice succeeding FC with 100% RDN, T₂: Rice succeeding FC with 75% RDN, T₃: Rice succeeding FC with 50% RDN, T₄: Rice succeeding RB with 100% RDN, T₅: Rice succeeding RB with 75% RDN, T₆: Rice succeeding RB with 50% RDN, T₇: Rice succeeding FM with 100% RDN, T₈: Rice succeeding FM with 75% RDN, T₉: Rice succeeding FM with 50% RDN, T₁₀: Rice succeeding FS with 100% RDN, T₁₁: Rice succeeding FS with 75% RDN, T₁₂: Rice succeeding FS with 50% RDN, T₁₃: Rice succeeding summer fallow (control treatment). All the treatments were replicated thrice. Plot size was 5m x 4m. The fodder cowpea variety used was CO 9 released from TNAU. It is of short duration (50 to 55 days), dwarf with reduced fibre portions which confers increased digestibility, palatability and intake. Bidhan-2 variety of rice bean released from Bidhan Chandra Krishi Viswavidyalaya (BCKV), Kalyani, West Bengal was used for the study. The variety has erect growth habit during early growth stage which later on becomes viny with indeterminate and luxuriant growth. The legume has profuse branching nature and grows to a height of 150 to 160 cm. Fodder maize variety African Tall was used which is bred at Mahatma Phule Krishi Vidyapeeth (MPKV), Kolhapur and is a composite of seven genotypes developed through modified mass selection. The average plant height is 260 cm. Fodder sorghum variety CO (FS) 31 was used for the study which is developed by TNAU, Coimbatore. It is a multi cut variety having a height of 270 to 290 cm. The rice variety used was Uma (MO-16) released from Rice Research Station, Moncompu, Alapuzha, Kerala Agricultural University. It is of medium duration (115 to 120 days), dwarf, medium tillering, non-lodging and resistant to brown plant hopper. Manures and fertilizers were applied as per the recommendations of TNAU for fodder cowpea, fodder maize and fodder sorghum. For rice bean as per the recommendations of AICRP on Forage crops and for the rice crop as per the Package of Practices of Kerala Agricultural University (KAU, 2016). Well decomposed FYM containing 0.5 per cent N, 0.2 per cent P₂O₅ and 0.4 per cent K₂O was applied as source of organic manure. Urea (46% N), rock phosphate (20% P₂O₅) and Muriate of potash (K₂O 60%) were used as inorganic sources of N, P and K respectively.

The residual effect of fodder crops under different levels of nitrogen on succeeding rice crop was assessed in terms

of growth and growth attributes, yield and yield attributes and economics of rice crop. For which, two rows of plants were left as border on all the sides and observations on parameters associated with growth and yield of rice were taken from the net plot area. Ten hills were randomly selected from the net plot area and plants were tagged for recording observations. The following observations were recorded from these sample plants and mean values were worked out. Among the growth attributes, the plant height and number of tillers were recorded at 20 DAT, 40 DAT and at harvest, following the method described by Gomez (1972). The plant height was measured from the ground level to tip of the longest leaf or tip of the longest ear head and mean is expressed in cm. The tiller number per hill was recorded from the observational plants, mean was worked out and expressed as numbers per hill. In case of yield attributes and yield, at the time of harvest, productive tillers m^{-2} , thousand grain weight, grain yield and straw yield were recorded, harvest index was worked out. Number of productive tillers was recorded from tagged plants in the net plot and expressed as number of productive tillers m^{-2} . Thousand numbers of clean, dry, fully filled grains were counted from the produce of each plot and the weight noted in grams.

Each net plot was harvested individually, threshed, dried, winnowed and air dry weight of grains recorded and grain yield was expressed as kg ha^{-1} . The straw was harvested from each net plot, dried under sun to a constant weight and straw yield was expressed as kg ha^{-1} . The harvest index was worked out using the formula suggested by Donald and Hamblin (1976).

$$\text{Harvest index (HI)} = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}}$$

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,

$$\text{Net income (₹ ha}^{-1}\text{)} = \text{Gross income (₹ ha}^{-1}\text{)} - \text{Total cost of cultivation (₹ ha}^{-1}\text{)}.$$

B: C ratio was calculated using the formula

$$\text{B: C ratio} = \frac{\text{Gross income (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

The experimental data were analyzed statistically by using Analysis of Variance technique for RBD (Cochran and Cox, 1965) and the significance was tested using F test. Wherever the F values were found significant, critical difference was calculated at five per cent probability level.

RESULTS AND DISCUSSION

The data on plant height of first crop of rice is represented in the Table 1. Significantly taller plants at 20 DAT were recorded in T_{12} which was on par with T_{11} , all the treatments of rice bean, T_8 and T_9 in fodder maize. The plant height differed significantly between treatments and control. At 40 DAT, the plant height was significantly higher in rice crop which succeeded fodder cowpea with 50 per cent RDN, which was on par with all other treatments except fodder cowpea with 75 per cent RDN. The plant height did not differ significantly between treatments and control. At harvest, significantly taller plants were observed in T_{10} which was on par with T_{11} , T_4 and T_6 in rice bean, T_7 and T_8 in fodder maize, T_{13} in fallow treatment. But, there was no significant difference between the treatments and control. The tillers m^{-2} did not

differ significantly between treatments at 20 and 40 DAT, and harvest (Table 2). Also, there was no significant difference between the treatments and control at 20 and 40 DAT and harvest.

The number of productive tillers m^{-2} did not differ significantly between treatments (Table 3). The productive tillers m^{-2} did not differ significantly between treatments and control. The thousand grain weight was not significantly influenced by the treatments (Table 3). The thousand grain weight did not differ significantly between treatments and control. The data on yield and harvest index is furnished in Table 3. There was no significant difference between treatments in grain yield, straw yield and harvest index. The treatments and control also did not differ significantly in case of grain yield, straw yield and harvest index.

The gross income, net income and B: C ratio did not differ significantly between treatments (Table 4). Also, the gross income, net income and B: C ratio did not differ significantly between treatments and control.

With respect to growth and yield of the rice crop, plant height alone exhibited a significant difference between the treatments at 20 and 40 DAS and at harvest. But, there was no specific pattern in the observed differences in plant height with regard to the preceding crops or varying doses of nitrogen.

It can be inferred that, despite two of the fodder crops raised during summer being legumes, the expected legume effect was not evident in growth or yield of rice. It is also interesting that reducing the level of N to the crops raised during summer did not have any adverse effect on the first crop of rice. The experiment was under taken in a field with a history of rice-rice-fallow sequence for the past several years. The stubble of the first and second crop was regularly incorporated in the soil. Moreover, the weeds of the summer fallow were also recycled. This might have resulted in a stabilized nutrient cycle and helped to override the adverse effect expected out of a reduction in N dose for the summer crop. Further, reducing the RDN for the summer crops did not have any adverse effect on the productivity and economics of the succeeding rice crop. Neither negative nor positive residual effects due to the inclusion of fodder crops during summer or owing to reduction of N dose for the summer crops were observed in the succeeding rice crop. It is to be noted that the rice crop was supplied with the recommended organic manure and nutrients.

Table 1: Effect of Treatments on Plant Height of Succeeding Rice Crop, cm

Treatments	20 DAT	40 DAT	At harvest
T ₁ : Rice succeeding FC with 100 % N	30.47	54.18	91.20
T ₂ : Rice succeeding FC with 75 % N	29.80	51.27	95.48
T ₃ : Rice succeeding FC with 50 % N	30.30	57.35	95.70
T ₄ : Rice succeeding RB with 100 % N	31.83	56.08	96.97
T ₅ : Rice succeeding RB with 75 % N	31.74	52.81	95.47
T ₆ : Rice succeeding RB with 50 % N	32.32	52.37	96.63
T ₇ : Rice succeeding FM with 100 % N	28.53	55.49	98.68
T ₈ : Rice succeeding FM with 75 % N	31.90	54.18	98.13
T ₉ : Rice succeeding FM with 50 % N	32.97	54.01	95.57
T ₁₀ : Rice succeeding FS with 100 % N	29.70	55.78	99.47
T ₁₁ : Rice succeeding FS with 75 % N	33.38	55.80	97.90
T ₁₂ : Rice succeeding FS with 50 % N	33.70	56.67	96.03
T ₁₃ : Rice succeeding summer fallow	28.59	54.91	97.20
SEm ($\pm$)*	0.892	2.055	1.060
CD (0.05)**	2.617	6.027	3.110
Treatment vs. control	S	NS	NS

*Standard Error of Mean

**Critical Difference

Table 2: Effect of Treatments on Number of Tillers m⁻² of Succeeding Rice Crop

Treatment	20 DAT	40 DAT	At harvest
T ₁ : Rice succeeding FC with 100 % N	100	585	377
T ₂ : Rice succeeding FC with 75 % N	107	496	329
T ₃ : Rice succeeding FC with 50 % N	139	551	308
T ₄ : Rice succeeding RB with 100 % N	108	525	341
T ₅ : Rice succeeding RB with 75 % N	128	524	304
T ₆ : Rice succeeding RB with 50 % N	89	493	330
T ₇ : Rice succeeding FM with 100 % N	119	517	332
T ₈ : Rice succeeding FM with 75 % N	133	580	309
T ₉ : Rice succeeding FM with 50 % N	127	526	323
T ₁₀ : Rice succeeding FS with 100 % N	119	503	337
T ₁₁ : Rice succeeding FS with 75 % N	120	459	362
T ₁₂ : Rice succeeding FS with 50 % N	97	528	337
T ₁₃ : Rice succeeding summer fallow	111	495	283
SEm (±)	14.13	53.53	27.07
CD (0.05)	NS	NS	NS
Treatment vs. control	NS	NS	NS

Table 3: Effect of Treatments on Yield Attributes and Yield of Succeeding Rice

Treatment	Productive Tillers m ⁻²	Thousand Grain Weight (g)	Grain Yield (kg ha ⁻¹)	Straw Yield (kg ha ⁻¹)	Harvest Index
T ₁ : Rice succeeding FC with 100 % N	296	25.88	3750	4667	0.45
T ₂ : Rice succeeding FC with 75 % N	268	25.19	3250	3833	0.46
T ₃ : Rice succeeding FC with 50 % N	267	24.96	3417	4125	0.45
T ₄ : Rice succeeding RB with 100 % N	240	25.21	3333	3625	0.48
T ₅ : Rice succeeding RB with 75 % N	254	24.21	2967	3367	0.47
T ₆ : Rice succeeding RB with 50 % N	251	24.46	3250	3750	0.47
T ₇ : Rice succeeding FM with 100 % N	284	24.93	3375	3875	0.47
T ₈ : Rice succeeding FM with 75 % N	263	24.76	3250	3792	0.46
T ₉ : Rice succeeding FM with 50 % N	267	24.21	3083	3792	0.45
T ₁₀ : Rice succeeding FS with 100 % N	307	24.48	4000	4667	0.46
T ₁₁ : Rice succeeding FS with 75 % N	311	24.13	3667	4042	0.47
T ₁₂ : Rice succeeding FS with 50 % N	283	24.31	3250	3958	0.45
T ₁₃ : Rice succeeding summer fallow	235	23.39	3167	3500	0.47
SEm (±)	19.99	0.52	257.01	284.87	0.02
CD (0.05)	NS	NS	NS	NS	NS
Treatment vs. control	NS	NS	NS	NS	NS

Table 4: Effect of Treatments on Economics of Cultivation of Succeeding Crop of Rice

Treatment	Gross Income (₹ ha ⁻¹)	Net Income (₹ ha ⁻¹)	B:C Ratio
T ₁ : Rice succeeding FC with 100 % N	135833	45833	1.51
T ₂ : Rice succeeding FC with 75 % N	116667	26667	1.30
T ₃ : Rice succeeding FC with 50 % N	123125	33125	1.37
T ₄ : Rice succeeding RB with 100 % N	118125	28125	1.31
T ₅ : Rice succeeding RB with 75 % N	105833	15833	1.18
T ₆ : Rice succeeding RB with 50 % N	116250	26250	1.29
T ₇ : Rice succeeding FM with 100 % N	120625	30625	1.34
T ₈ : Rice succeeding FM with 75 % N	116458	26458	1.29
T ₉ : Rice succeeding FM with 50 % N	111458	21458	1.24

T ₁₀ : Rice succeeding FS with 100 % N	143333	53333	1.59
T ₁₁ : Rice succeeding FS with 75 % N	130208	40208	1.45
T ₁₂ : Rice succeeding FS with 50 % N	117292	27292	1.30
T ₁₃ : Rice succeeding summer fallow	112500	22500	1.25
SEm ($\pm$)		8637.35	0.09
CD (0.05)		NS	NS
Treatment vs. control		NS	NS

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