Effect of crop stand establishment and nutrient management of Rice on growth, yield and economics of rice fallow sunhemp

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Abstract

A field experiment was conducted for two consecutive years (2017 -18 and 2018-19) at the Agricultural College Farm, Naira. The treatments consisted of two main plots Wet seeded rice (Drum seeding) and transplanting method and four sub plots viz. S_1: 100% RDF (Chemical fertilizers); S_2: 75% RDF+ 25% RDF through FYM; S_3: 75% RDF + 25% RDF through green manure crop **(***Sunhemp***)***; S_4: 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop* **(***Sunhemp***).** *During rabi sunhemp is sown as rice fallow crop for seed purpose. Significant increase in growth and yield attributes of rice fallow crop sunhemp remained with the treatment, which received 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop (S_4) which was however at par with 75% RDF+ 25% RDF through FYM (S_2) during both the years of study.*

The residual effect of INM treatments imposed in kharif rice on succeeding rice fallow sunhemp, resulted in recording higher net return and higher return rupee^{-1} investment with 50% RDF along with 25% RDF through FYM + 25% RDF through green manure crop which was at par with 75% RDF + 25% RDF through FYM during both the years of study.

Keywords: Sunhemp, Rice Fallow, Rabi, Crop Management.

Introduction

Sunhemp is an important green manure crop which is widely used as green manure crop during *kharif and* later incorporated during puddling for rice. Large quantities of drymatter will add to the soil and will help to increase soil physical properties and it will also add nitrogen to the soil. The demand for sunhemp seed is increasing because of its potential benefits as green manure. The availability of organic sources was reduced due to reduction in draft animals and also due to conversion of crop residues into organic matter. Demand for sunnhemp seeds may be approximately estimated to be 2 million tonnes considering green manuring possibilities in rice and sugarcane crops only with a seed rate of 20 kg ha^{-1}.

This crop is being deep rooted and can resist against moisture stress, it can grow with residual moisture and nutrients[4]. Under rice fallow condition, blackgram crop is growing as rice fallows for many years, the crop is not economically feasible to the farmer even though it is considered as bonus crop to the farmer. For effective utilization of residual moisture and nutrients and where the crop can be given with one or two irrigations, this crop is more beneficial to the farmer as this crop is also belonging to legume family. Identifying a suitable crop stand strategy in rice based cropping system and developing a sound viable nutrient management practice for North Coastal Zone was proposed with the following objectives.

1. To investigate the response of rice crop to methods of crop establishment and nutrient management.
2. To assess the soil property changes on yield maximization and reduced production cost of rice – based cropping system as a whole.
3. To find out the residual effect of nutrition management and method of crop stand establishment on succeeding *Rabi*, crop.

Material and Methods

The experimentation was conducted during both *kharif* and *Rabi* seasons and during *kharif*, experiment was laid out in split plot design with three replications. The treatments consisted of two main plots: Wet seeded rice (Drum seeding) and transplanting method and four sub plots *viz*. S_1: 100% RDF (Chemical fertilizers); S_2: 75% RDF+ 25% RDF through FYM; S_3: 75% RDF + 25% RDF through green manure crop **(**Sunhemp**)**; S_4: 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop **(**Sunhemp**).** During rabi, sunhemp is sown as rice fallow crop for seed purpose. The experimental soil was sandy loam in texture, slightly acidic in reaction and 0.35% in organic carbon, 229 kg ha^{-1} in available nitrogen, 29 kg ha^{-1} in available phosphorus and 268 kg ha^{-1} in potassium.

The experiment was designed in split plot with three replications during both the years of *kharif*, 2017-18 and 2018-19. The second year of experimentation comprised of 24 plots of 13×5 m during *kharif* to study different establishment methods of rice along with different fertilizer treatments which include organic and inorganic sources.

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During *rabi*, 72 plots of 24×3 m dimensions were laid out for different rice fallow pulse crops during both the years i.e. 2017-18 and 2018-19 respectively. Rice crop before its harvest, each sub-plot was divided into 3 equal plots by using a rope for easy differentiation of the plots and convenient for sowing *rabi* fallow crops.

Sunhemp seeds were soaked in water during morning hours and stored in tied gunny bag overnight for quick and early germination. Bold and healthy seeds of sunhemp were broadcasted under rice fallow condition. To obtain required plant population fallow crops were sown ensuring sufficient moisture in the rice field. Sunhemp crop is having more duration when compared to rice fallow blackgram and similar duration of rice fallow ragi crop.

The residual moisture might not be sufficient for the entire crop growth period and the residual nutrients are also not sufficient as sunhemp crop is also heavy feeder as it produces more yield. Hence, minimum of two irrigations was provided for the crop to avoid moisture stress. Even though the crop is legume crop and having deep root system moisture, nutrients can absorb from deeper layers. Two foliar sprays with 19:19:19 were given to protect the crop from nutrient stress during the critical stages of crop growth. The cost of seed was more than blackgram and ragi and hence the return per rupee invested was high in rice fallow sunhemp.

Results and Discussion

Plant height was significantly affected by fertilizer treatments. At harvest significantly higher plant height was attained (123 cm) in S_4 where 50% of RDF was added through organic sources and the lowest was recorded in 100% RDF only through chemical sources (113.9 cm). The superiority of individual plant performance attributed to less competition for nutrients, moisture, space and solar radiation finally led towards better growth and development of plants. The results are in conformity with the findings of Shastri et al[6] and Tripathy et al[9]. At 60 DAS significant increase in leaf area was noticed, that all the treatments which were given with organic sources along with inorganic fertilizers at different proportions, performed better due to retention of moisture, there by the leaf area by absorbing more moisture and nutrients. Significantly S_4 (7.46) 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop (sunhemp) and S_2 (7.23) 75% RDF + 25% RDF through FYM were at par and superior to S_3 (6.80) 75% RDF + 25% RDF through green manure crop (sunhemp) and S_1 (5.83) 100% RDF (chemical fertilizers) were at par.

Crop growth was increasing with increasing trend up to 60 DAS. When the crop attains to maturity, the photosynthetic activity in the leaves will get declined and will get reduced at the time of maturity. All the organic source treatments at 30-60 DAS S_4 (27.0), S_3 (22.23) and S_2 (23.05) showed significantly higher CGR than RDF i.e. S_1 (19.17). RGR was significantly highest from 60 DAS - harvest S_4 (0.0222) 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop (sunhemp) was significantly superior over S_2 75% RDF + 25% RDF through FYM, $S_3$75% RDF +25% RDF through green manure crop (sunhemp) and lowest was recorded with S_1 (0.0176) 100% RDF (chemical fertilizers).

Table 1

Plant height (cm), Leaf Area Index, Crop Growth Rate, Relative Growth Rate and Net Assimilation Rate of rice fallow sunhemp as influenced by crop stand establishment and nutrient management in rice during*rabi.*

Treatments	Plant height at Harvest (cm)	LAI at 60 DAS	CGR at 60 DAS - Harvest	RGR at 60 DAS - Harvest	NAR at 60 DAS - Harvest
***Rabi*: Sunhemp**					
M_1	119.8	7.18	23.77	0.0202	0.00891
M_2	117.8	6.42	21.95	0.0190	0.00863
SEm+	2.81	0.16	0.38	0.001	0.001
CD (P=0.05)	NS	NS	NS	NS	NS
CV (%)	8.19	8.24	5.74	5.38	6.07
Fertilizer treatments (Organic and in-organic sources)					
S_1	113.9	5.83	19.17	0.0176	0.00789
S_2	120.2	7.10	23.05	0.0199	0.00890
S_3	118.3	6.80	22.23	0.0187	0.00838
S_4	123.0	7.46	27.00	0.0222	0.00989
SEm+	2.01	0.15	1.09	0.001	0.001
CD (P=0.05)	6.21	0.46	3.36	0.001	0.001
CV (%)	4.15	5.49	11.70	5.70	5.23
Interaction	NS	NS	NS	NS	NS

S_1: 100% RDF (Chemical fertilizers)
S_2: 75% RDF+ 25% RDF through FYM
S_3: 75% RDF + 25% RDF through green manure crop (Sunhemp)
S_4: 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop (Sunhemp)

Table 2

Drymatter Production, No. of Pods per plant, No. of Seeds per pod, Test weight, Grain Yield and Economics of rice fallow sunhemp as influenced by crop stand establishment and nutrient management during Rabi

Treatments	Drymatter Production (Kg/ha)	No. of Pods per plant	No. of Seeds per pod	Test weight (gms)	Grain Yield (Kg/ha)	Gross return (Rs)	Net return (Rs)	Return per rupee invested
Rabi: Sunhemp								
M_1	4299	26.53	15.10	37.80	964	74273	56698	3.25
M_2	4112	25.69	14.46	36.70	910	70279	52704	3.01
SEm±	76.55	0.52	0.45	0.30	22.33	1595	1595	0.09
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	6.30	6.88	10.55	2.81	8.25	7.6	10.1	10.0
Fertilizer treatments (Organic and in-organic sources)								
S_1	3649	23.61	13.49	34.62	787	60912	43337	2.48
S_2	4395	26.48	15.30	38.34	995	76672	59097	3.38
S_3	4176	25.61	14.58	36.58	916	70720	53145	3.04
S_4	4603	28.75	15.75	39.47	1050	80800	63225	3.62
SEm±	113.48	0.69	0.45	0.64	28.12	1992	1992	0.12
CD (P=0.05)	349.67	2.12	1.38	1.98	86.60	6137	6137	0.35
CV (%)	6.61	6.47	7.42	4.23	7.34	6.7	8.9	9.0
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

S_1: 100% RDF (Chemical fertilizers); S_2: 75% RDF+ 25**%** RDF through FYM; S_3: 75**%** RDF + 25**%** RDF through green manure crop **(**Sunhemp**)**; S_4: 50**%** RDF + 25**%** RDF through FYM + 25**%** RDF through green manure crop **(**Sunhemp**)**

At 60 DAS-harvest NAR was significantly recorded the highest with S_4 (0.00989) 50% RDF + 25% RDF through FYM + 25% RDF and green manure crop **(**sunhemp) treatment which was superior over S_2 75% RDF + 25% RDF through FYM, S_3 75% RDF + 25% RDF through green manure crop (sunhemp) and the lowest NAR was recorded with S_1 (0.00789) 100% RDF (chemical fertilizers). The growth rate will be high in the early stages of crop growth. During 60 DAS - harvest, all the three treatments that were applied with organic sources in combination with inorganic sources were performed which were better than S_1, this might be due to less NAR from 60 DAS - harvest.

At harvest significantly highest drymatter production (4603 kg ha^{-1}, 4395 kg ha^{-1} and 4176 kg ha^{-1}) was recorded with S_4 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop **(**sunhemp**)**, which is at par with $S_2$75% RDF + 25% RDF through FYM and S_3 75% RDF + 25% RDF through green manure crop (sunhemp). Lowest drymatter production was recorded with S_1 100% RDF (chemical fertilizers) treatment. More is the dry matter, the plant will grow more luxuriantly and can give more yield. These findings are in conformity with Santosh et al[5] and Triveni[9] in diancha.

Significant number of pods were produced in S_4 (28.75) 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop **(**sunhemp**)**and S_2 (26.48) 75% RDF + 25% RDF through FYM than with S_3 (25.61) 75 % RDF + 25 % RDF through green manure crop (sunhemp) and S_1 (23.61) 100% RDF (chemical fertilizers) treatments. This might be due to vigorous growth of the plant which facilitates to put forth more number of pods per plant also confirmed by Kumar et al[1] and Triveni[9]. Among treatments, significant variation in number of seeds pod^{-1} was recorded in all the organic sources applied plots.

Treatments S_4 (15.75)50**%** RDF + 25% RDF through FYM + 25% RDF through green manure crop **(**sunhemp**)**, S_2 (15.3) 75% RDF + 25% RDF through FYM and S_3 (14.58) 75 % RDF + 25% RDF through green manure crop (sunhemp) were significantly superior over S_1 (13.49) 100% RDF (chemical fertilizers) in which no organic sources were applied. This might be due to availability of nutrients and moisture will enhance the number of seeds pod^{-1} due to uninterrupted supply in confirmation with Kumar et al[1]. Significant variation in test weight was recorded in S_4 (39.47) 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop **(**sunhemp**)**and S_2 (38.34) 75% RDF + 25% RDF through FYM than with S_3 (36.58) 75% RDF + 25% RDF through green manure crop (sunhemp) and S_1 (34.62) 100% RDF (chemical fertilizers) treatments.

The residual effect of fertilizer treatments applied to rice on succeeding sunhemp grain yield was noticeably higher with application of 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop **(**sunhemp**)**S_4 and S_2 75% RDF + 25% RDF through FYM which was significantly higher over S_1, however, which was at par to S_3. There was no significant difference between the residual effect of $S_1$100% RDF (chemical fertilizers) and S_3 on grain yield of rice fallow sunhemp. The residual effect of fertilizer treatments applied to rice on succeeding crop significantly produced high yield also reported by Marimuthu et al[2].

Maximum gross return, net return and return per rupee invested were significantly recorded with 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop (S_4) and 75% RDF + 25% RDF through FYM (S_2). Application of 50% RDF + 25% RDF through FYM + 25% RDF through green manure crop applied to preceding rice in rice-rice fallow sunhemp sequence recorded significantly higher gross return, net return and return per rupee invested. This could be due to high availability and utilization of nitrogen by the crop from inorganic sources whereas release of nitrogen from organic source may not be full during the crop growth period. These findings are in conformity with Singh et al[7] and Pandey et al[3].

Conclusion

Integration of organic and inorganic sources i.e. 25% RDF through green manure crop and 25% RDF through FYM ha^{-1} in combination with 50% RDF (chemical fertilizers) showed the residual effect by improving available nutrient status and soil moisture retention capacity. During *rabi*, rice fallow crop, sunhemp manifested the maximum growth, yield attributes, nutrient uptake, gross returns, net returns and returns $rupee^{-1}$ investment with integration of organic and inorganic sources i.e. 25% RDF through green manure crop and 25% RDF through FYM ha^{-1} in combination with 50% RDF (chemical fertilizers).

Rice- rice fallow sunhemp registered the higher system productivity, system returns and system efficiency. The above research findings revealed that combined application of inorganic and organic sources (75% RDF along with 25**%** RDF through green manure crop) was effective in realizing higher grain yield and returns of rice cultivation besides improving soil physical properties and residual fertility for rice fallow crops. Among different crops in rice based sequence, sunhemp is the best choice.

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(Received 10th October 2025, accepted 11th November 2025)