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Technologies to enhance the productivity and profitability of semi dry rice in Telangana

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Abstract
A field investigation was carried out during June-September, 2016 and 2017 at College Farm, Agricultural College, Aswaraopet, Bhadradri Kothagudem Dist of Telangana State of India in sandy clay loam soil to evaluate the economic performance of semi dry rice under integrated nutrient and weed management practices. Three nutrient treatments as main plots{100% RDF, 75% RDF + 25% N through vermicompost and 75% RDF + 25% N through FYM} and four weed management practices {S_1: Control, S_2: Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* HW @ 20, 40 DAS, S_3: Bispyribac sodium 10 SC 25 g ha^{-1} (Early PoE) *fb* (Fenoxaprop-p-ethyl @ 62.5 g a.i ha^{-1} + 2,4 – D 80 WP 0.5 kg a.i ha^{-1}) at 35 - 40 DAS and S_4: Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10 WP 25 g ha^{-1} + 2, 4-D 80 WP 0.5 kg a.i ha^{-1}) + HW @ 50 DAS}were imposed as sub plot treatments in split plot design replicated thrice. Significantly, enhanced grain & straw yield and economic returns were noticed with 75% RDF + 25% N through vermicompost. Among weed management practices, Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10 WP 25 g ha^{-1} + 2, 4-D 80 WP 0.5 kg a.i ha^{-1}) + HW @ 50 DAS} registered significantly higher yield and economic returns. Interaction effect of nutrient and weed management practices on grain and straw yield and economics was found to be significant.

Keywords: Economics, nutrients, organics, semi dry rice, weed and yield

Introduction
Rice (*Oryza sativa* L.) is staple food grain grown widely in more than 100 countries of the world. Almost 90% of the world's rice is produced and consumed in Asia to provide up to three-fourths of the total calories required by 520 million Asians (Yogananda *et al*. 2019) [30]. A stupendous increase of 26% and 50% of global rice production is demanded to meet the requirements of exploding population by 2035 and 2050, respectively (IRRI 2020) [15].
Globally, rice is grown in acreage of 162.06 M ha with production of 755.47 M t and productivity of 4661 kg ha^{-1} (Anonymous 2020) [15]. India ranks second after China with production of 177.65 million metric tons. Rice occupies an area of 43.66 M ha with production and productivity of 118.87 M t and 2723 kg ha^{-1}, respectively in India. In Telangana, rice is grown in an area of 3.19 M ha with production of 11.12 M t and productivity of 3483 kg ha^{-1} (Anonymous 2020) [15].
Rice plays a unique role in Indian economy among South Asian countries. Major share of rice is cultivated during *kharif* season. Several constraints involved with transplanted puddled rice are huge water demand (1000–2000 mm), high energy requirement of 5630–8448 MJ $ha^{-1}$and 15–20% higher labor inputs (Saharawat *et al*. 2010) [27] compared to direct-seeded rice, which made it unaffordable for small and marginal farmers of Southeast Asia (Bhatt *et al*. 2016) [8]. In order to overcome all these disadvantages of transplanted rice, semi dry rice system of cultivation is a good solution where rice is treated as rainfed crop for 40-45 days before being switched to wet crop when enough water is available (Chatterjee and Maiti, 1985 and Rathinasamy, 2021) [9, 26].
Integrated nutrient management is regarded as a valuable tool for small and marginal farmers to increase crop yield and profitability on a long-term basis (Jaya shankar *et al*. 2017; Bharadwaj *et al*. 2019) [16, 7]. Both crop and weeds respond to increase in soil fertility.

Initial dose of nitrogen fertilizer may be delayed and usage of organic manures starve the weed growth initially and fertilizer application should be done after effective weed control and under appropriate soil moisture conditions (Nagargade *et al*. 2018; Goswami *et al*. 2018 and Barla *et al*. 2021) [23, 13, 6]. To achieve high rice yields, both integrated nutrient and weed management are essential and proper nutrient management in semi dry rice reduces the crop weed competition and therefore should be applied as per requirement of the crop. Due to concurrent crop and weed growth, absence of standing water in the initial crop establishment phase weed insurgence is aggravated (Dadsena *et al.* 2018 and Jehangir *et al*. 2021) [10, 17]. Weeds can be suppressed effectively either by hand weeding, through herbicides or by combination of both methods during critical period of weed competition (15-60 days after seeding) and minimal yield losses can be noticed. Hence, it is perceived that efficient weed management is a key to success in semi dry rice (Soujanya 2020, Saharawat *et al*. 2020 and Naganjali *et al*. 2021) [27, 29, 22].

Materials and Methods

Semi dry rice was sown in *kharif* (June – September, 2016 and 2017) at College Farm, Agricultural College, Aswaraopet, Bhadradri Kothagudem District, Professor Jayashankar Telangana State Agricultural University in Telangana State. Experimental site is situated in the Central Telangana Agro climatic Zone at an altitude of 162 m above mean sea level at $17^0$24'54" N latitude and $81^0$10'34 E longitude. The weather pertaining to crop growth period was favorable during *kharif* both the years of experimentation. Soil is analyzed and characterized as sandy clay loam with pH of 6.72, low in available nitrogen (204 kg N ha^{-1}), medium in available phosphorus (29.1 kg P_2O_5 ha^{-1}) and potassium (273 kg K_2O ha^{-1}).

The field experiment was conducted for two years in two *kharif* seasons during 2016 and 2017 with semi dry rice crop. The experiment was laid out in split plot design with main plots as three levels of nutrient management (M_1 - 100% RDF, M_2 - 75% RDF + 25% N through vermicompost and M_3 - 75% RDF + 25% N through FYM) while, subplots consisted of four weed management practices *i.e.* S_1 – Control, S_2- Bispyribac sodium 10% SC @25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS, S_3 - Bispyribac sodium 10% SC @25 g ha^{-1} (Early PoE) *fb* (Fenoxaprop-p-ethyl @ 62.5 g a.i ha^{-1} + 2,4 – D 80% WP @ 0.5 kg a.i ha^{-1}) at 35 - 40 DAS and S_4 - Bispyribac sodium 10% SC @25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10% WP @ 25 g ha^{-1} + 2, 4-D 80% WP @ 0.5 kg a.i ha^{-1}) + HW @ 50 DAS in semi dry rice during *kharif* season. Variety of rice chosen was KNM – 118. Recommended dose of fertilizer was 100:50:40 N, P_2O_5, K_2O kg ha^{-1} as urea, single super phosphate and muriate of potash. Nitrogen was applied in three equal splits at sowing, maximum tillering and panicle initiation stage. Phosphorous was applied as basal dose at sowing and potassium was applied in two splits at sowing and panicle initiation stage.

5 kg zinc sulphate along with 20 kg urea was dissolved in 500 litres of water ha^{-1} and was sprayed at 25 and 40 DAS to control *khaira* (Zn deficiency). In order to ameliorate iron deficiency, ferrous sulphate @ 5 g lt^{-1} was sprayed with 1 g of citric acid at 15 DAS. Same practices were followed for both the years 2016 and 2017 in semi dry rice.

Herbicides as per treatment were sprayed as pre-emergence at one day after sowing of the crop, early-post emergence at 12 and 14 DAS and as post-emergence at 25 and 26 DAS of the crop in *kharif* 2016 and 2017. The herbicide spray solution was prepared with the required quantity of herbicide at the rate of 500 litres water ha^{-1} for each plot. The spray solution for the individual plot was prepared separately as per the treatment. Gross plot size and net plot size were 6.0 m x 4.8 m and 5.2 m x 4.2 m respectively during both seasons. Grain and straw yield were recorded separately from each treatment's net plot area and converted to per hectare yield, and expressed in kg ha^{-1}. Gross returns were calculated by multiplying the economic yield with the prevailing market price and expressed as ₹ ha^{-1}. Net return of each treatment was calculated separately by subtracting the cost of cultivation from the gross return and expressed as ₹ ha^{-1}. Benefit-Cost ratio was calculated by using the following formula as given by Perin *et al*. (1979) [24]. The data collected from the experiment were analyzed statistically by analysis of variance method for split plot design (Gomez and Gomez, 1984). Economics was worked out for rice with the following formula

$$\text{Benefit-Cost ratio} = \frac{\text{Gross returns (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}} \quad (1)$$

Results and discussion

Yield

Grain Yield (kg ha^{-1})

Amongst nutrient management practices, 75% RDF + 25% N through vermicompost (M_2) yielded highest grain yield of 4060 and 4436 kg ha^{-1} which was comparable with 75% RDF + 25% N through FYM *i.e.* M_3(3702, 4270 kg ha^{-1}), M_1 treatment with 100% RDF yielded the lowest yield of 3198 and 3467 kg ha^{-1} during *kharif* 2016 and 2017.

During *kharif* 2016 and 2017 (Table 1), highest grain yields of 4845 and 5400 kg ha^{-1}achieved by S_4[Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10 WP 25 g ha^{-1} + 2, 4-D 80 WP 0.5 kg a.i ha^{-1}) + HW @ 50 DAS] and was statistically equivalent with S_2[Bispyribac sodium10 SC 25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS] (4619 and 5133 kg ha^{-1}). Unlike S_4, the control treatment had minimum yield of 1828 and 1983 kg ha^{-1} (Table 1).

Combination with 75% RDF and 25% N through vermicompost or FYM provided slow, continuous release and greater availability and uptake of macro and micro-nutrients and active participation in carbon assimilation, photosynthesis, starch formation, sugar and protein translocation, water entry to the root of plants, etc. resulting in increased dry matter, source and sink capacity and ultimately yield. The findings agreed with those of Gayatree *et al*. (2017) [11], Mondal *et al*. (2020) [21] and Ram *et al*. (2020) [25].

An integrated weed management approach *i.e.* sequential application of pre-and post-emergence, broad spectrum and tank mixture herbicides with different mode of actions as well as hand weeding ensured to combat weed menaces in semi dry rice and prevent changes in weed community structure throughout the crop growth period might have improved source and sink capacity *viz.*, no. of panicles m^{-2} and total no. of grains $panicle^{-1}$, which expedited higher production of yield as stated by Singh and Pandey (2019) [19].

Straw Yield (kg ha^{-1})

M_2 *i.e.*75% RDF + 25% N through vermicompost increased straw yield (4850, 5235 kg ha^{-1}) to statistically comparable level with M_3[75% RDF + 25% N through FYM] (4635, 5039 kg ha^{-1}). During the two-year study (Table 1), the chemically fertilized treatment yielded less straw of 4131, 4346 kg ha^{-1}.

Apart from nutrient practices, over two successive years (Table 1), S_4 *i.e.* Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10 WP 25 gha^{-1} + 2, 4-D 80 WP 0.5 kg a.i ha^{-1}) + HW @ 50 DAS produced higher straw yields of 5452 and 5929 kg ha^{-1} as compared to S_2[Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS] (5333, 5776 kg ha^{-1}), respectively. S_3 *i.e.* Bispyribac sodium 10 SC 25 g ha^{-1} (Early PoE) *fb* (Fenoxaprop-p-ethyl 62.5 g a.i ha^{-1} + 2,4 – D 80 WP 0.5 kg a.i ha^{-1}) at 35 - 40 DAS was the next best treatment, with straw yields of 4530 and 4796 kg ha^{-1}. The control treatment, S_1, produced the least amount of straw (2839, 2993 kg ha^{-1}).

In neither of the two years, there was interaction effect of nutrient and weed management practices on straw yield.

An increase in straw output with integrated nutrient management treatments emphasizes the differentiation process from the somatic to the reproductive phase. Enhanced straw yield might be partly attributed to its direct influence on dry matter production of vegetative parts *viz.*, such as plant height, leaf area and number of tillers etc. while indirectly through enhanced morphological growth parameters. Meena *et al.* (2019) [20] found similar results.

Application of herbicide mixtures suppressed diversified group of weeds than single herbicide application. Season long weed free condition was linked to luxuriant crop growth with higher plant height, leaf area, number of tillers and higher dry matter production enhanced straw yield. The control produced the lowest straw yield of rice due to intense weed competition for growth resources. The results of this study agree with those of Hemalatha *et al.* (2017) [14].

Table 1: Yield of semi dry rice influenced by nutrient and weed management (*Kharif*, 2016 & 2017)

Treatments	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	2016	2017	2016	2017
Nutrient Management (M)				
M_1	3197	3467	4131	4346
M_2	4060	4436	4850	5235
M_3	3702	4270	4635	5039
SEm±	100	108	138	131
CD (*P=0.05*)	394	425	542	513
Weed management (S)				
S_1	1828	1983	2839	2993
S_2	4619	5133	5333	5776
S_3	3320	3716	4530	4796
S_4	4845	5400	5452	5929
SEm±	91	120	94	125
CD (*P=0.05*)	270	356	280	371
Interaction				
S × M				
SEm±	157	208	163	216
CD (*P=0.05*)	468	617	NS	NS
S × M				
SEm±	196	242	228	264
CD (*P=0.05*)	560	677	NS	NS

Nutrient Management

M_1 – 100% RDF

M_2 – 75% RDF + 25% N through Vermicompost

M_3 - 75% RDF + 25% N through FYM

Weed Management

S_1 - Control

S_2 - Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS

S_3 - Bispyribac sodium 10 SC 25 g ha^{-1} (Early PoE) *fb* (Fenoxaprop-p-ethyl 62.5 g a.i ha^{-1} + 2,4 – D 80 WP 0.5 kg a.i ha^{-1}) at 35-40 DAS

S_4 - Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10 WP 25 g ha^{-1} + 2, 4 – D 80 WP 0.5 kg a.i ha^{-1}) + HW at 50 DAS

Economics

Cost of cultivation (₹ ha^{-1})

Data pertaining to nutrient treatments (Table 2) revealed that, cost involvement was highest with M_2[75% RDF + 25% N through vermicompost] (₹ 36813 ha^{-1}) followed by M_3[75% RDF + 25% N through FYM] (₹ 32779 ha^{-1}) and found the lowest with M_1[100% RDF] (₹ 26506 ha^{-1}).

Weed management practices (Table 2) emphasized that S_2 [Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS] incurred more costs (₹ 34682 ha^{-1}) followed by S_4[Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10 WP 25 g ha^{-1} + 2, 4-D 80WP 0.5 kg a.i ha^{-1}) + HW @ 50 DAS] (33776 ₹ ha^{-1}) and S_3[Bispyribac sodium 10 SC 25 g ha^{-1} (Early PoE) *fb* (Fenoxaprop-p-ethyl 62.5 g a.i ha^{-1} + 2,4–D 80 WP 0.5 kg a.i ha^{-1}) at 35 - 40 DAS] (₹ 31939 ha^{-1}). Lowest costs were experienced in un-weeded control plots (₹ 27732 ha^{-1}).

Among the various treatment combinations, the highest total cost of cultivation was recorded in integration of fertilizers and organic manures and lowest was noticed in 100% chemical fertilizers where crop was left weedy throughout the twoseasons.

Highest costs incurred might be due to more prizes for purchase of organic manures and their application in bulk quantity as compared to synthetic fertilizers (Ashim *et al.* 2021 and Anjali *et al.* 2022) [5, 1].

Two hand weedings along with herbicide usage was accountable for enhanced cost of cultivation. Rising wages of labour and their non-availability at peak time discourage hand weeding and this situation urged for alternative weed control through herbicides (Soujanya, 2020 and Kumar *et al.* 2022) [29].

Gross Returns (₹ ha^{-1})

With regard to nutrient treatments imposed in both the years of study (Table 2), the highest gross returns were showed with M_2[75% RDF + 25% N through vermicompost] (₹ 63714, 70393 ha^1) which was however statistically indistinguishable with M_3[75% RDF + 25% N through FYM] (₹ 58313, 66956 ha^{-1}) over two years while M_1[100% RDF] (₹ 50494, 54616 ha^{-1}) had put forth lowest gross returns.

With respect to weed management practices in both years of study (Table 2), the highest gross returns were exhibited with S_4[Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10WP 25 g ha^{-1} + 2, 4-D 80 WP 0.5 kg a.i ha^{-1}) + HW @ 50 DAS] (₹ 75700, 84223 ha^{-1}) which was at par with S_2[Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS] (72315, 80198 ₹ ha^{-1}) and both of them were significantly superior compared to S_3[Bispyribac sodium 10 SC 25 g ha^{-1} (Early PoE) *fb* (Fenoxaprop-p-ethyl 62.5 g a.i ha^{-1} + 2,4 – D 80 WP @ 0.5 kg a.i ha^{-1}) at 35 - 40 DAS]. Unweeded control attained significantly the lowest net returns of ₹ 29343, 32858 ha^{-1} in the semi dry rice.

Higher gross returns in semi dry rice were due to slow and steady release of nutrients might have created congenial environment for enhanced grain and straw yields as suggested by Aruna *et al*. (2016) [4].

Hand weeding and the use of pre- and post-emergence herbicide mixtures are both effective methodsof weedcontrol. As previously documented by Gupta and Tomar (2019) and Soujanya (2020) [29], reduced crop-weed competition resulted in greater use of nutrients, moisture, light and space, as well as decreased pest-disease incidence, helped in increased grain and straw productivity and hence higher gross returns.

Net Returns (₹ ha^{-1})

Significant variation among the nutrient treatments was not exhibited over two consecutive years (Table 2). However, M_2[75% RDF + 25% N through vermicompost] (₹26901, 32747 ha^{-1}) produced highest and statistically equivalent net returns to M_3[75% RDF + 25% N through FYM] (₹25535, 34261 ha^{-1}) and M_1[100% RDF] (₹ 23988, 28111 ha^{-1}).

Net returns were higher with S_4[Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10 WP 25 g ha^{-1} + 2, 4-D 80 WP 0.5 kg a.i ha^{-1}) + HW @50 DAS] (₹ 41924, 50447 ha^{-1}) which was statistically equivalent to S_2 [Bispyribac sodium 10 SC @25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS] (₹ 40376, 48259 ha^{-1}), subsequently S_3 [Bispyribac sodium 10 SC 25 g ha^{-1} (Early PoE) *fb* (Fenoxaprop-p-ethyl 62.5 g a.i ha^{-1} + 2,4 – D 80 WP 0.5 kg a.i ha^{-1}) at 35-40 DAS] (₹ 17987, 23992 ha^{-1}). S_1 recorded lowest returns (₹ 1611, 4126 ha^{-1}) out of all the treatments in both the years (Table 2).

In spite of higher cost of cultivation, enhanced yield output and gross returns had contributed for higher net returns by following the integrated nutrient management (Meena *et al*. 2019 and Anjali *et al*. 2022) [1].

Higher grain yield was produced by reduced weed density and weed dry matter as a result of effective season long weed control in all of the weed management treatments compared to the control treatment. Another reason ascertained could be due to the treatments linked with weed management practices were more profitable than control in terms of net monetary returns as recommended earlier by Martin *et al*. (2020) [1].

B-C Ratio

Regarding nutrient management practices in *kharif* 2016 and 2017, the benefit- cost ratio was found to be the highest with M_1[100% RDF] (1.88, 2.03) at par with M_3[75% RDF + 25% N through FYM] (1.76, 2.02) and M_2[75% RDF + 25% N through vermicompost] (1.71, 1.86). However, M_1, M_2 and M_3were at par with each other (Table 2).

Under different weed management practices, benefit-cost ratio was found to be highest with S_4[Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10 WP 25 g ha^{-1} +2,4-D 80 WP 0.5 kg a.i ha^{-1}) + HW @ 50 DAS (2.25, 2.49) which was statistically similar with S_2 under Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS] (2.09, 2.32). S_3[Bispyribac sodium10 SC 25 g ha^{-1} (Early PoE) *fb* (Fenoxaprop-p-ethyl 62.5 g a.i ha^{-1} + 2,4 – D 80 WP 0.5 kg a.i ha^{-1}) at 35 - 40 DAS] recorded a lower B-C ratio of 1.53 & 1.70, whereas control recorded significantly lowest B-C ratio (1.07, 1.16) over other treatments in the two consecutive years (Table 2).

Highest benefit-cost ratio realized was probably due to effective control of all category of weeds at critical stages leading to increased growth parameters, yield components and yield which lead to increased B-C ratio with sequential application of herbicides in combination with one hand weeding or pre-emergence herbicide application followed by two hand weedings, while lowest B-C ratio was observed in control due to less grain yield. Based on the availability of labour farmer can opt either of the integrated weed management practices. These results are in conformity with Gupta and Tomar (2019) and Martin *et al*. (2020) [19].

Table 2: Economics of semi dry rice influenced by nutrient and weed management (*Kharif*, 2016 & 2017)

Treatments	Cost of cultivation (₹ ha^{-1})		Gross returns (₹ ha^{-1})		Net returns (₹ ha^{-1})		B-C Ratio	
	2016	2017	2016	2017	2016	2017	2016	2017
Main plots: Nutrient Management (M)								
M_1	26506	26506	50494	54616	23988	28111	1.88	2.03
M_2	36813	36813	63714	70393	26901	32747	1.71	1.86
M_3	32779	32779	58313	66956	25535	34261	1.76	2.02
SEm±			1425	928	386	864	0.048	0.041
CD (*P=0.05*)			5595	3643	1515	3394	NS	NS
Sub plots: Weed Management (S)								
S_1	27732	27732	29343	32858	1611	4126	1.07	1.16
S_2	34682	34682	72315	80198	40376	48259	2.10	2.32
S_3	31939	31939	52670	58674	17987	23992	1.53	1.70
S_4	33776	33776	75700	84223	41924	50447	2.25	2.49
SEm±			1200	1565	641	1991	0.043	0.061
CD (*P=0.05*)			3565	4649	1904	5914	0.16	0.18
Interaction								
S × M								
SEm±			2078	2710	1110	3448	0.074	0.106

CD ($P=0.05$)			NS	NS	NS	NS	NS	NS
			S × M					
SEm±			2651	2914	1196	3589	0.093	0.116
CD ($P=0.05$)			NS	NS	NS	NS	NS	NS

Nutrient Management
M_1 – 100% RDF
M_2 – 75% RDF + 25% N through Vermicompost
M_3 - 75% RDF + 25% N through FYM

Weed Management
S_1 - Control
S_2 - Bispyribac sodium 10% SC @25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS
S_3 - Bispyribac sodium 10% SC @25 g ha^{-1} (Early PoE) *fb* (Fenoxaprop-p-ethyl @ 62.5 g a.i ha^{-1} + 2,4 – D 80% WP @ 0.5 kg a.i ha^{-1}) at 35-40 DAS
S_4 - Bispyribac sodium 10% SC @25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10% WP @ 25 g ha^{-1} + 2, 4 – D 80% WP @ 0.5 kg a.i ha^{-1}) + HW at 50 DAS PE – Pre-Emergence, Early PoE – Early Post Emergence, HW – Hand Weeding, DAS – Days After Sowing, SC – Soluble Concentrate, WP – Wettable Powder, a.i. – Active ingredient, FYM – Farm Yard Manure, VC – Vermicompost

Conclusion
Nutrient management practices, M_2 *i.e.* 75% RDF + 25% N through vermicompost and among weed management practices, S_4 *i.e.* Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* (Pyrazosulfuron ethyl 10 WP 25 g ha^{-1} + 2, 4-D 80 WP 0.5 kg a.i ha^{-1}) + HW @ 50 DAS recorded maximum yield and economic returns. Higher B-C ratio was realized with S_2 [Bispyribac sodium 10 SC 25 g ha^{-1} (PE) *fb* Hand weeding @ 20, 40 DAS].

Future Research
Principles of site-specific nutrient management (SSNM) and precision farming for semi dry rice can be evaluated. Studies on organic farming under semi dry rice can be taken up. Persistence and dissipation behaviour of new generation herbicides for rice have to be worked out.

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