RESPONSE OF NUTRIENT AND WEED MANAGEMENT PRACTICES ON YIELD AND ECONOMICS OF SEMI DRY RICE

ABSTRACT:A field experiment was laid out at College Farm, Agricultural College, Aswaraopet, Bhadradri Kothagudem Dist., Professor Jayashankar Telangana State Agricultural University, Telangana State during *kharif*, 2016 and 2017.Treatments comprised of three main plots as nutrient management [M_1 - 100% RDF, M_2 - 75% RDF + 25% N through vermicompost and M_3 - 75% RDF + 25% N through FYM] and four sub plots as weed management [S_1 – Control, S_2 - Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* Hand weeding @ 20, 40 DAS, S_3 - Bispyribac sodium 10% SC @25 g ha^{-1} (Early Po Emg.) *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} (Pre-Emg.) *fb* (Pyrazosulfuron ethyl 10 % WP @ 25 g ha^{-1}+ 2, 4-D 80% WP @ 0.5 kg a.i ha^{-1}) +HW @ 50 DAS]. Results revealed that highest grain and straw yields, gross and net returns were highest with 75% RDF + 25% N through vermicompost and Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* (Pyrazosulfuron ethyl 10 % WP @ 25 g ha^{-1}+ 2, 4-D 80% WP @ 0.5 kg a.i ha^{-1}) +HW @ 50 DAS. However, B-C ratio did not show any significant influence with nutrient treatments while highest B-C ratio was found with Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* Hand weeding @ 20, 40 DAS.

Key words: Semi dry rice, Economics, vermicompost, Bispyribac sodium and Pyrazosulfuron ethyl.

1. INTRODUCTION: Rice (*Oryza sativa* L.) is primary food crop grown widely in more than 100 countries of the world. Globally in 2020, rice is grown in acreage of 162.06 M ha with production of 755.47 M t and productivity of 4661 kg ha^{-1} (FAOSTAT, 2019-20). 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} (CMIE, 2019-20).

Semidry rice (Dry direct seeded) has various advantages over puddled transplanted rice, including easier planting, timely sowing, less labour, 7-10 days earlier crop maturity, reduced water demand, lower production costs and enhanced profits (Kumar and Ladha, 2011). It is devoid of nursery raising, puddling and transplanting activities, resulting in 25% reduction in human labour for rice farming (Dhanapal *et al*., 2018).

Both crop and weeds respond to increase in soil fertility. Initial dose of nitrogen fertilizer may be delayed and usage of organic manures starves the weed growth initially and fertilizer application should be done after effective weed control and under appropriate soil moisture conditions (Nagargade *et al*., 2018). To achieve high rice yields, both nutrient and weed management are essential and proper nutrient management in direct seeded rice reduces the crop weed competition and therefore should be applied as per requirement of the crop.

Rice crop responded effectively to high N fertilizer application in weed-free circumstances. Due to rice's superior competitive ability, losses from weeds decreased as fertility levels increased (Rao *et al*., 2007).

In semi dry rice, due to the concurrent crop and weed growth, absence of standing water in the initial crop establishment phase aggravates weed insurgence. 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 (Kapila Shekawat *et al*., 2020).

MATERIALS AND METHODS: The present experiment was carried out at College Farm, Agricultural College, Aswaraopet, Bhadradri Kothagudem Dist., Professor Jayashankar Telangana State Agricultural University, Telangana State situated at an altitude of 162 m above mean sea level at $17^0$24’54” N latitude and $81^0$10’34 E longitude which is located in the Central Telangana Agro Climatic Zone. Congenial weather conditions prevailed during *kharif* 2016 and 2017. Total precipitation received during the cropping period was 524.60 mm and 572.8 mm in 30 and 32 rainy days in 2016 and 2017 respectively. The experiment was laid out in split plot design with three replications comprising of 3 main plot treatments with 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} (Pre-Emg.) *fb* Hand weeding @ 20, 40 DAS, S_3 - Bispyribac sodium 10% SC @25 g ha^{-1} (Early Po Emg.) *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} (Pre-Emg.) *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. Semi dry rice (variety KNM-118) was sown in 1^{st}Fortnight of July at a spacing of 20 cm × 15 cm with a seed rate of 50 kg ha^{-1}. Herbicides were applied using a knapsack sprayer fitted with flat fan nozzle calibrated to deliver 500 litres of water per hectare. Recommended dose of fertilizer (RDF) for the crop was 100:50: 40 kg N, P_2O_5, K_2O kg ha^{-1}through urea, SSP 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.

Grain yield was recorded separately from each treatment's net plot area and converted to per hectare yield, after which the grain was sun-dried to moisture content of 12 percent, later, cleaned, weighed, and expressed grain yield in kg ha^{-1}.After separating the grains, left over straw from each net plot treatment was sun dried until a constant weight and yield per plot was recorded and expressed in kg ha^{-1}. The straw harvested from the net plot area of each treatment was sun dried until constant weight and straw yield per plot was recorded and expressed in kg ha^{-1}.

The total cost of cultivation for rice was calculated for all the treatments on the based-on inputs used for each treatment. 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) and Palaniappan (1985).

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

3. RESULTS AND DISCUSSION:

3.1 Grain yield (kg ha^{-1}):

Grain yield is a function of genotype and environment. In rice, yield is determined by indirect traits like plant height, growth period, tillering ability, panicle length, seed setting rate and grains per panicle as well as direct traits like panicle number per unit area and/or per plant, filled grains per panicle and 1000-grain-weight. Crop yields are influenced by biotic and abiotic factors. Yields can be increased, by implementing efficient nutrient and weed management practices at the proper time.

During *kharif* 2016 and 2017, the impact of nutrient and weed management practices on rice grain yield and their interaction was noteworthy. Grain yield was higher in *kharif* 2017 compared to 2016 year as presented in table 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 3197 and 3467 kg ha^{-1} during *kharif* 2016 and 2017.

During *kharif* 2016 and 2017, highest grain yields of 4845 and 5400 kg ha^{-1} achieved by S_4 [Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *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 sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *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}.

Combination with 75% RDF and 25% N through vermicompost or FYM provided slow and continuous release of better nutrients to crop at different growth intervals, allowing the crop to assimilate adequate photosynthetic products, resulting in increased dry matter, source and sink capacity and ultimately yield. The findings agreed with those of Borah *et al*. (2015), Gayatri*et al*. (2017) and Rishikesh *et al*. (2020).

An integrated weed management approach with the hand weeding and herbicides with different mode of actions 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 Priyanka *et al*. (2019) and Abhinandan Singh and Pandey (2019).

3.2 Straw yield (kg ha^{-1})

During both years of the experiment, the straw yield of semi dry rice was statistically different, however, interaction effect was not significant with nutrient and weed management practices following an unchanging pattern as presented in the table 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, the chemically fertilized treatment yielded less straw of 4131, 4346 kg ha^{-1}.

Apart from nutrient practices, over two successive years,S_4*i.e.*Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* (Pyrazosulfuron ethyl 10 % WP @ 25 g ha^{-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} (Pre-Emg.) *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 Po Emg.) *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 4796kg 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.

Enhanced nutrient supply had improved metabolic activity and cell division, leading to increased growth traits such as plant height, leaf area, number of tillers and higher dry matter production, resulting in higher rice straw output. Meena *et al*. (2019) found similar results.

Luxuriant crop growth with higher plant height, leaf area, number of tillers and higher dry matter production, coupled with less crop weed competition at critical growth stages, resulted in higher straw yield. The control produced the lowest straw yield of rice due to intense weed competition for growth resources, and thereby lowered straw yield. The results of this study agree with those of Sylvestre *et al*. (2019) and Neha Sharma *et al*. (2021).

3.3Economics

Table 1 displays results of an economic study of semi dry rice crop with varied nutrient practices against weed management practices. The costs incurred in growing rice crop under various treatments have been summed up and calculated gross and net returns and B-C ratio for *kharif* 2016 and 2017.

3.4Cost of cultivation (□ ha^{-1})

Data pertaining to nutrient treatments 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 emphasized that S_2 [Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* Hand weeding @ 20, 40 DAS] incurred more costs (□ 34682 ha^{-1}) followed by S_4 [Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* (Pyrazosulfuron ethyl 10 % WP @ 25 g ha^{-1} + 2, 4-D 80% WP @ 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 Po Emg.) *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 unweeded 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 when crop was left weedy throughout the two seasons.

Highest costs incurred might be due to more prize for purchase of organic manures and their application in bulk quantity as compared to synthetic fertilizers (Shalini, 2017 and Ashim *et al*., 2021).

Two hand weedings along with herbicide usage was accountable for enhanced cost of cultivation (Geetha, 2016 and Soujanya, 2020).

3.4 Gross Returns(□ ha^{-1})

Gross returns of semi dry rice differed significantly with nutrient and weed management practices with unaltered trend during both the years (Table 1). Gross returns were highest in 2017 than in 2016 due to relatively higher yields obtained.

With regard to nutrient treatments imposed in both the years of study, the highest gross returns were showed with M_2 [75% RDF + 25% N through vermicompost](□ 63714, 70393ha^{-1})

which was however statistically indistinguishable with M_3[75% RDF + 25% N through FYM] (□ 58313, 66956ha^{-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, the highest gross returns was exhibited withS_4[Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* (Pyrazosulfuron ethyl 10 % WP @ 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} (Pre-Emg.) *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 Po Emg.) *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 Shekara *et al*. (2011), Aruna *et al*. (2016) and Neha Sharma *et al*. (2021).

Hand weeding and the use of pre- and post-emergence herbicide mixtures are both effective methods of weed control. As previously documented by Patel *et al*. (2018), Gupta and Tomar (2019) and Soujanya *et al*. (2020), 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.

3.5 Net Returns (□ ha^{-1})

Net returns were significantly influenced by weed management practices in both the years of study whereas the nutrient treatments and their interaction did not display any significant difference (Table 1).

Significant variation among the nutrient treatments was not exhibited over two consecutive years. 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, 28111ha^{-1}).

Net returns were higher with S_4 [Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *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} (Pre-Emg.) *fb* Hand weeding @ 20, 40 DAS] (□ 40376, 48259 ha^{-1}), subsequently S_3 [Bispyribac sodium 10% SC @25 g ha^{-1} (Early Po Emg.) *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.

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 (Shalini *et al*., 2017 and Hemaraj Meena *et al*., 2019).

Higher grain yield was provided by reduced weed density and weed dry matter as a result of effective weed control in all of the weed management treatments compared to the control treatment. Another reason ascertained could be due to all treatments linked with weed management practices were more profitable than control in terms of net monetary returns as recommended earlier by Dhanapal (2018), Madhav Dhakal *et al*. (2019), Sylvestere (2019) and Patil *et al*. (2020).

3.6 B-C Ratio

B-C ratio of semi dry rice had significantly varied with weed management practices in *kharif* 2016 and 2017 while nutrient management and interaction of nutrient and weed management treatments was not significant (Table 1).

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_3 were at par with each other.

Under different weed management practices, benefit-cost ratio was found to be highest with S_2 [Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* Hand weeding @ 20, 40 DAS] (2.27, 2.52) which was statistically similar with S_4 under Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *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). S_3 [Bispyribac sodium 10% SC @25 g ha^{-1} (Early Po Emg.) *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.

Highest benefit-cost ratio realized was probably due to effective control of all category of weeds at critical stages leading to increased growth parameter, yield components and yield which lead to increased B-C ratio in integrated weed management. In spite of increased cost of cultivation, B-C ratio was higher for weed free treatment than chemical treatment alone might be due to closer cost of cultivation incurred for all treatments. This suggests that farmer can opt for integrated weed management with one hand weeding compared to two hand weedings due to scarcity of labour. These results are in conformity with Arya (2015), Sreenivasulu *et al*. (2016), Gupta and Tomar (2019) and Patil *et al*. (2020).

CONCLUSION:

Monetary returns are the key indicators in assessing the success of new technologies. In our study, highest net returns were fetched either with 75% RDF + 25% N through vermicompost/FYM or 100% chemical fertilizers. But, in the long run, for sustainable production and maintenance of soil health, integrated use of organic manures and inorganic fertilizers is the only viable option with respect to nutrient management practices. As far as weed management practices are concerned, Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* (Pyrazosulfuron ethyl 10 % WP @ 25 g ha^{-1}+ 2, 4-D 80% WP @ 0.5 kg a.i ha^{-1}) + HW @ 50 DAS had registered highest net returns which was comparable with Bispyribac sodium 10% SC @25 g ha^{-1} (Pre-Emg.) *fb* Hand weeding @ 20, 40 DAS. Due to scarcity of labour, pre-emergence followed by post-emergence herbicide along with one hand weeding is the feasible method for efficient weed control and productivity of rice crop without sacrificing the yields.

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Table 1: Grain and straw yield (kg ha^{-1}) and economics of semi dry rice influenced by nutrient and weed management practices during *kharif*, 2016 & 2017.

Treatments	**Grain yield (kg ha^{-1})**		**Straw yield (kg ha^{-1})**		**Cost of cultivation (□ ha^{-1})**	**Gross returns (□ ha^{-1})**		**Net returns (□ ha^{-1})**		**B-C Ratio**	
	2016	**2017**	**2016**	**2017**	**2016 & 2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
Main plots: Nutrient Management(M)											
M_1	3197	3467	4131	4346	26506	50494	54616	23988	28111	1.88	2.03

M_2	4060	4436	4850	5235	36813	63714	70393	26901	32747	1.71	1.86
M_3	3702	4270	4635	5039	32779	58313	66956	25535	34261	1.76	2.02
SEm±	100	108	138	131		1425	928	386	864	0.05	0.04
CD *(P=0.05)*	394	425	542	513		5595	3643	1515	3394	NS	NS
Sub plots: Weed Management (S)											
S_1	1828	1983	2839	2993	27732	29343	32858	1611	4126	1.07	1.16
S_2	4619	5133	5333	5776	34682	72315	80198	40376	48259	2.27	2.52
S_3	3320	3716	4530	4796	31939	52670	58674	17987	23992	1.53	1.70
S_4	4845	5400	5452	5929	33776	75700	84223	41924	50447	2.25	2.49
SEm±	91	120	94	125		1200	1565	641	1991	0.04	0.06
CD *(P=0.05)*	270	356	280	371		3565	4649	1904	5914	0.13	0.18
Interaction											
S × M											
SEm±	157	208	163	216		2078	2710	1110	3448	0.07	0.11
CD *(P=0.05)*	468	617	NS	NS		NS	NS	NS	NS	NS	NS
M × S											
SEm±	196	242	228	264		2651	2914	1196	3589	0.09	0.12
CD *(P=0.05)*	560	677	NS	NS		NS	NS	NS	NS	NS	NS