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Evaluation of rice fallows under zero till system with limited irrigation

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ABSTRACT

A field experiment was conducted on sandy loam soils to study the impact of weeds and limited number of irrigations in six different crops under zero till system in rice fallows during *Rabi*, 2021-22 at Agricultural College Farm, Naira, Andhra Pradesh, India. The experiment was laid out in spit-plot design, replicated thrice with three irrigations and six crops as subplot treatments. The weed count and weed dry weight ware non-significant with number of irrigations in six rice fallow crops at 20 and 40 DAS. At 60 DAS weed count weed dry weight and their interaction effect was significantly influenced with number of irrigations in six fallow crops. The Blackgram equivalent yield with number of irrigations in six fallow crops was significant. The interaction effect of Blackgram equivalent yield with number of irrigations and six fallow crops was significant. The highest Blackgram equivalent yield was noticed with four irrigations (1423 kg ha^{-1}) and decreased significantly and gradually with reduction in number of irrigations and recorded lowest Blackgram equivalent yield with two irrigations (1104 kg ha^{-1}). The Blackgram equivalent yield was 87.84 % with three irrigations and 77.58 % with two irrigations. The Blackgram equivalent yield was recorded significantly highest in Sorghum crop (2636 kg ha^{-1}) followed by Maize, Sunhemp, Fingermillet and Blackgram while the lowest was recorded in Mustard (347 kg ha^{-1}). The interaction effect with Blackgram equivalent yield was significant and recorded maximum with four irrigations in maize crop (2975 kg ha^{-1}) and minimum yield was recorded with two irrigations in Mustard crop (284 kg ha^{-1}) which was however, on parity with four irrigations (354.9 kg ha^{-1}).

Keywords: *Blackgram equivalent yield, Limited irrigation, Rice fallows and Zero-till system.*

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One of the key challenges of 25th century is to devise ways of producing sufficient amounts of food while protecting both environment and economic wellbeing of rural communities. Global demand for grain crops is expected to grow rapidly in the coming decades. Upscaling system productivity and to ensure country's food security, sustainable intensification of traditional cropping systems is indispensable. Rice (*Oryza sativa* L.) fallow (~14 million ha) is a typical monocrop rice-based system of south Asia (particularly India including Andhra Pradesh), presently gaining larger attention as promising means for sustainable intensification. Efficient utilization of these fallow lands may increase the productivity and make the whole system sustainable. Soil condition and climatic situation clearly suggest that short duration crop can easily be fit in that situation. The resources present in the rice fallows clearly giving an opportunity to introduce succeeding crops into the situation. It will surely be an excellent inclusion. If the location specific constraints are being managed efficiently, then those unutilized lands can be efficiently converted into productive one. It will not only increase the production of the system but also strengthen the economic condition of the farmers, improve the soil. Rice is grown during *Kharif* season which is normally followed by a fallow during the *Rabi* season. Therefore, the present investigation was carried out in rice-fallows under zero-tillage conditions in enhancing the productivity. Identification of an alternate crop that can successfully establish and yield good profits with little moisture and minimum farm operations under zero-till system involving rice as a principal crop was a long felt need for North Coastal Zone and hence the present study "Evaluation of rice fallow crops under zero-till system with limited irrigation**"** is carried out to assess the performance of alternate crops.

MATERIALS AND METHODS

A field experiment was conducted at Agriculture College Farm, Naira Andhra Pradesh

during *rabi*, 2021-2022. The soil of the experimental site was sandy loam in texture, with pH 7.2, organic carbon 0.38 %, available nitrogen 225 kg ha^{-1}, available P_2O_5 31 kg ha^{-1} and available K_2O 275 kg ha^{-1}. The weather conditions during the crop growth period were normal.

The experiment was laid out in a split plot design, replicated thrice with three irrigation levels *viz.*, two irrigations (I_1), three irrigations (I_2) and four irrigations (I_3) assigned to main plots and with six different crops in sub plots *viz.*, Maize (C_1), Sorghum (C_2), Fingermillet (C_3), Mustard (C_4), Sunhemp (C_5) and Blackgram (C_6) irrigated at their crop critical growth stages with check basin method of irrigation.

The cultivars used for the experiment in six crops were Maize seed is of hybrid variety DKC 9150, Sorghum seed is of variety CSH 16, Finger millet seed of variety is Sri Chaitanya, Mustard seed of variety Pusa Mustard 28, Sunhemp seed of variety Shailesh (SH-4) and Blackgram seed of variety LBG 787 were procured for sowing. Seeds of maize and sorghum were dibbled at recommended spacing and other seeds of finger millet, mustard, sunhemp and blackgram were broadcasted uniformly. Sowings were done at 14th December, 2021 in residual soil moisture after the harvest of paddy crop. To maintain optimum plant population, gap filling was done at 15 DAS and thinning was done at 20 DAS. Three hand weedings at fortnightly intervals were carried out starting from 20, 40 and 60 DAS to keep the plots free from weeds. Fertilizer was applied as per the recommended doses and method of application of respective crops. The crops were grown on residual soil moisture up to first irrigation and there after irrigations were given as per the treatments. The data was recorded with respect to weed count and evaluated over time by counting the number of emerged weeds in four randomly placed 0.25 m^{-2} quadrants at 20, 40 and 60 DAS in each sub-sub plot of the experiment. Within each quadrant, weeds were counted and recorded. After above-ground weed biomass was collected in four randomly placed 0.25 m^{-2} quadrants at 20, 40 and 60 DAS to record dry weight. Within each quadrant, plants were cut at the soil surface, placed into brown paper bags and dried in a forced-air oven at 60°C for three days. The data was recorded with respect to Blackgram equivalent yield of different crops were recorded and calculated by multiplying the economic yield of different crops with the price kg^{-1} of different crops and divided by price of blackgram kg^{-1} in the local market by making use of the following formula.

$$\text{Blackgram equivalent yield} = \frac{\text{Yield of different crops (kg)} \times \text{Price of different crops /kg}}{\text{Price of Blackgram /kg}}$$

RESULTS AND DISCUSSION

Weed density at 20, 40 and 60 DAS:

Data regarding weed count at 20, 40 and 60 DAS are presented in table 1.0. The weed count was non-significant with number of irrigations in six fallow crops at 20 and 40 days after sowing DAS. At 60 DAS weed density was significantly influenced by number of irrigations in six fallow crops. The interaction effect at 60 DAS on weed density was significant and presented in table 1.1. Significantly highest weed density was recorded with four irrigations (84.05 m^{-2}) and lowest weed density was recorded with two irrigations (72.30 m^{-2}). Among six different crops highest and lowest weed density was observed in the Maize and Blackgram respectively.

With regard to the interaction effect there is significant difference with number of irrigations and six fallow crops. The highest weed density was recorded with three irrigations which was however on par with four irrigations in sorghum crop. Lowest weed count was recorded with two irrigations in mustard.

Weed dry weight at 20, 40 and 60 DAS:

The weed dry weight was non-significant with limited number of irrigations in six fallow crops at 20 and 40 days after sowing. At 60 DAS weed dry weight and its interaction effect was significantly influenced by number of irrigations in six fallow crops. The weed dry weight at 20, 40 and 60 DAS are presented in table 2.0. The interaction effect at 60 DAS on weed dry weight was significant and presented in table 2.1. Significantly highest weed dry weight was recorded with four irrigations (56.19 gm m^{-2}) and lowest was recorded with two irrigations (45.73 gm m^{-2}). Among six different crops highest weed dry weight was observed in Maize crop (58.43 gm m^{-2}) and lowest with Sunhemp crop (47.44 gm m^{-2}). The interaction effect was significant with number of irrigations and six fallow crops. The highest weed dry weight was recorded in maize with four irrigations (64.77gm m^{-2})

and lowest weed dry weight was recorded with two irrigations (42.47 gm m^{-2}) in sunhemp which was however, observed on par with three irrigations in Sunhemp (46.97 gm m^{-2}).

At 60 DAS the weed count and weed dry weight is more compared to 20 and 40 DAS due to higher available soil moisture because of the irrigation and nutrient supplement to the main crops. At initial stages of crop growth generally there will be less competition for weeds with main crop as a result there will be superiority of weeds over crop plants. Later on weed population was increased by utilizing all the resources that were provided to main crop at initial stages of crop growth. Hence the weed density and dry weight at 60 DAS was recorded higher when compared with 20 and 40 DAS. Weed count and weed dry density was low at 20 and 40 DAS mainly due to hand weeding in the fallow crops which results finally in yield improvement. These findings are in corroborations with those reported by Adusumilli Narayana Rao (2021), Sandhya Rani *et al*. (2021), Venkateswarlu *et al*. (2018), Parameswari *et al*. (2017) and Sumitra Devi Bamboriya *et al.* (2017).

Blackgram equivalent seed yield (Kg ha^{-1}) of six fallow crops with limited number of irrigations

The Blackgram equivalent yield with number of irrigations in six different crops was presented in table 3.0. Significant difference was observed with number of irrigations and with six fallow crops. The interaction effect between number of irrigations and six fallow crops was statistically measurable.

The Blackgram equivalent yield was recorded highest with four irrigations (1423 kg ha^{-1}) and decreased significantly and gradually with reduction in number of irrigations and recorded lowest with two irrigations (1104 kg ha^{-1}). The Blackgram equivalent yield was higher by 87.84 % with three irrigations and 77.58 % with two irrigations. The Blackgram equivalent yield among six fallow crops was recorded highest in Sorghum crop (2636 kg ha^{-1}) followed by Maize, Sunhemp, Fingermillet and Blackgram while the lowest was recorded in Mustard (347 kg ha^{-1}). The interaction effect of Blackgram equivalent yield between number of irrigations and six different crops was significant and statistically measurable presented in table 3.0. The Blackgram equivalent yield was recorded highest with four irrigations in maize crop (2975 kg ha^{-1}) and lowest Blackgram equivalent yield was recorded with two irrigations in Mustard crop (284 kg ha^{-1}) which was however, on parity with four irrigations (354.9 kg ha^{-1}). Blackgram equivalent yield was higher in crops with higher yields. Crops like Maize, Sorghum, Fingermillet and Sunhemp requires four irrigations for better growth and development of plant physically and physiologically which directly impacts the final yield of crop. Better management practices with timely input of nutrients and moisture at critical stages of crop growth will enhance the better flow of food materials from source to sink, improving plant vigour and resistance to different stresses finally able to produce expected yields. Mustard crop records better yield with three irrigations provided at critical stages of crop growth among two and four irrigations. Rice fallow blackgram shows significantly higher yields with two irrigations when given at most critical stages in flowering and pod formation stages. The results obtained in the present investigation also corroborating with the earlier findings of Piri *et al*. (2020), Lal *et al*. (2020), Alamin *et al.* (2019), Kobir *et al*. (2019) and Nazma *et al.* (2019).

CONCLUSION

Based on the experimental findings, it can be concluded that maize was the best option with four irrigations and sorghum was the best option when irrigations were limited to two to three under rice fallows during *rabi* in north coastal zone of Andhra Pradesh.

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Table 1.0 Weed density (no m^{-2}) at 20, 40 and 60 DAS in six fallow crops with limited number of irrigations

TREATMENTS	Weed counts 20 DAS	Weed counts 40 DAS	Weed counts 60 DAS
Main plots : Three (No of Irrigations)			
Two Irrigations	40.07	49.64	72.3
Three Irrigations	41	51.59	79.47
Four Irrigations	40.02	51.92	84.05
SEm±	1.262	0.934	1.593
CD (P=0.05)	NS	NS	6.255
CV (%)	13.26	7.761	8.598
Sub plots : Six (Different crops)			
Maize	44.8	57.77	92.03
Sorghum	44.22	55.52	88.66
Fingermillet	39	48.81	74.56
Mustard	39.41	46.63	73.85
Sunhemp	37.58	46.69	72.03
Blackgram	37.17	50.88	70.5
SEm±	1.135	0.957	1.463
CD (P=0.05)	NS	NS	4.225
CV (%)	8.437	5.626	5.583
Interaction			
SEm±	1.966	1.658	2.533
CD (P=0.05)	NS	NS	S

Table 1.1 Interaction effect of Weed density (no m^{-2}) at 60 DAS in six fallow crops with limited number of irrigations

Treatments	Weed counts 60 DAS			
	Two Irrigations	Three Irrigations	Four Irrigations	Mean
Maize	82.83	97.58	95.67	92.03
Sorghum	79.17	97.88	88.94	88.66
Fingermillet	68.15	73.92	81.6	74.56
Mustard	66.17	75.41	79.98	73.85
Sunhemp	71	65.33	79.75	72.03
Blackgram	66.46	66.67	78.38	70.5
Mean	73.3	79.47	84.05	

	SEm±	CD (p = 0.05)
Crops (S)	1.463	4.225
Number of Irrigations (M)	1.593	6.255
S at M	2.533	7.318
M at S	2.809	8.478

Table 2.0 Weed dry weight (gm m^{-2}) at 20, 40 and 60 DAS in six fallow crops with limited number of irrigations

TREATMENTS	Weed dry weight 20 DAS	Weed dry weight 40 DAS	Weed dry weight 60 DAS
Main plots: Three (No of Irrigations)			
Two Irrigations	12.59	25.46	45.73
Three Irrigations	13.23	25.66	51.22
Four Irrigations	13.22	26.08	56.19
SEm±	0.205	0.578	1.132
CD (P=0.05)	NS	NS	4.444
CV (%)	6.6	9.5	9.408
Sub plots : Six (Different crops)			
Maize	13.46	29.54	58.43
Sorghum	13.12	26.47	54.8
Fingermillet	12.37	24.64	49.64
Mustard	13.72	25.62	48.4
Sunhemp	12.31	22.44	47.44
Blackgram	13.09	25.67	47.56
SEm±	0.387	0.607	0.948
CD (P=0.05)	NS	NS	2.739
CV (%)	8.9	7	5.5
Interaction			
SEm±	0.67	1.051	1.642
CD (P=0.05)	NS	NS	S

Table 2.1. Interaction effect of Weed dry weight (gm m^{-2}) at 60 DAS in six fallow crops with limited number of irrigations

Treatments	Weed dry weight 60 DAS			
	Two Irrigations	Three Irrigations	Four Irrigations	Mean
Maize	51.53	59	64.77	58.43
Sorghum	45.67	57.53	61.2	54.8
Fingermillet	43.43	49.7	55.8	49.64
Mustard	45.9	46.57	52.73	48.4
Sunhemp	42.47	46.97	52.9	47.44
Blackgram	45.4	47.53	49.73	47.56
Mean	45.73	51.22	56.19	

	SEm±	CD (p = 0.05)
Crops (S)	0.948	2.739
Number of Irrigations (M)	1.132	4.444
S at M	1.642	4.745
M at S	4.038	5.71

Table 3.0 Interaction effect between limited number of irrigations and six fallow crops on Blackgram equivalent yield (Kg ha^{-1})

Treatments	Blackgram equivalent yield			
	Two Irrigations	Three Irrigations	Four Irrigations	Mean
Maize	1606	2121	2975	2234
Sorghum	2539	2619	2750	2636
Fingermillet	649.7	807.1	912.3	789.7
Mustard	284.6	401.6	354.9	347
Sunhemp	904.8	980.3	1062	982.4
Blackgram	639	572.6	481.6	564.4
Mean	1104	1250	1423	

	SEm±	CD (p = 0.05)
Crops (S)	22.99	66.4
Number of Irrigations (M)	27.59	108.3
S at M	40	115
M at S	46	138

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