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Research Article

GROWTH PARAMETERS OF RICE, ZERO TILL RAGI AS INFLUENCED BY NUTRIENT MANAGEMENT INTERVENTIONS

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Abstract: A field experiment was conducted during *kharif* and *rabi* seasons of 2017-18 and 2018-19 on sandy loam soil of the Agricultural College Farm, Bapatla. The experiment having seven treatments *i.e.*, T_1 : 100% RDF (100-60-40 kg N-P-K ha^{-1}) ; T_2: 100% RDF+ Soil application of $ZnSO_4$ @ 50 kg ha^{-1} ; T_3: 125% RDF+ Soil application of $ZnSO_4$ @ 50 kg ha^{-1}; T_4: 75% RDF+ Poultry manure @ 0.82 t ha^{-1} + Soil application of $ZnSO_4$ @ 50 kg ha^{-1}; T_5: 75% RDF+ FYM @ 5.0 t ha^{-1} + Soil application of $ZnSO_4$ @ 50 kg ha^{-1}; T_6: 50% RDF+ Poultry manure @1.6 t ha^{-1}+ Soil application of $ZnSO_4$ @ 50kg ha^{-1} and T_7: 50% RDF+ FYM @ 10 t ha^{-1}+ Soil application of $ZnSO_4$ @ 50 kg ha^{-1}. The experiment was laid out in Randomized Block Design and replicated thrice during *kharif* rice and in *rabi* each *kharif* treatment was sub divided into four sub treatments (S_1:no fertilizer, S_2: 100% RDF, S_3: 75% RDF and S_4: 50% RDF) and hence, the split plot design was adopted. Total No. of plots per each replication in the *rabi* was 28 (7x4= 28). Among all the *kharif* treatments, T_7 was recorded maximum growth parameters *viz*., plant height (), No. of tillers (), LAI () and SPAD reading () in rice. While in *rabi*, S_2: 100% RDF was recorded maximum plant height () and No. of tillers () in ragi in both the years of study in pooled data.

Keywords: *Plant height, LAI, SPAD meter reading, Nutrient Management Interventions, Rice- Ragi sequence*

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Introduction

Rice is one of the most important staple food crops in India grown over 43.9 million hectares with a total production of 99.24 million tonnes and an average productivity of 24.94 q ha^{-1} [1]. Now a day's rice productivity is not enough to meet the food need of every hungry mouth of this country hence, the only alternative left is vertical increase in yield since expansion of area is not possible. In wetland rice, conjunctive use of chemical fertilizers, organic sources for realization of yield sustainability on long run basis. Finger millet is an important rainfed crop, due to its resilience and ability to withstand adverse weather conditions when grown in soils having poor water holding capacity. Finger millet can thrive well under residual moisture and fertility in rice fallows. At present rice fallow pulse sequence facing many problems *viz*., yellow mosaic virus and *Visia sativa* weed. In India, finger millet is grown in the area of 1.06 m. ha with production of 1.68 m. t and productivity of 1363 kg ha^{-1}. In Andhra Pradesh, it is grown in the area of 0.032 m. ha with production of 0.035 m t and productivity of 1094 kg ha-1 (Ministry of Agriculture, Govt of India, 2018-19 [1].

Material and Methods

The present investigation was conducted at Agricultural College Farm, Bapatla. It is located in coastal region of Krishna Agroclimatic Zone of Andhra Pradesh. It is situated at 15º54' N latitude and 80º25' E longitude with an altitude of 5.49 meters above the mean sea level (MSL) and about 8 km away from the Bay of Bengal coast. The soil was sandy loam in texture, slightly alkaline in reaction, low in organic carbon, available nitrogen and available phosphorus and medium in available potassium.

The trial was laid out in a Randomized block design with seven treatments in *kharif* rice and in *rabi* it was modified to split plot design and replicated thrice. The seven treatments consisted of T_1 : 100% RDF (100-60-40 kg N-P-K ha^{-1}) ; T_2: 100% RDF+ Soil application of $ZnSO_4$ @ 50 kg ha^{-1}; T_3: 125% RDF+ Soil application of $ZnSO_4$ @ 50 kg ha^{-1}; T_4: 75% RDF+ Poultry manure @ 0.82 t ha^{-1} + Soil application of $ZnSO_4$ @ 50 kg ha^{-1}; T_5: 75% RDF+ FYM @ 5.0 t ha^{-1} + Soil application of $ZnSO_4$ @ 50 kg ha^{-1}; T_6: 50% RDF+ Poultry manure @1.6 t ha^{-1}+ Soil application of $ZnSO_4$ @ 50kg ha^{-1} and T_7: 50% RDF+ FYM @ 10 t ha^{-1}+ Soil application of $ZnSO_4$ @ 50 kg ha^{-1}. In *rabi* each *kharif* treatment divided into four sub treatments (S_1:no fertilizer, S_2: 100% RDF, S_3: 75% RDF and S_4: 50% RDF) and the design will be changed to split plot design. For plant height, five successive plants were sampled and tagged in each plot and height, LAI, SPAD meter reading was measured at 30, 60, 90 DAT and at harvest in rice. No. of tillers per meter was measured randomly in each plot in rice and ragi. The data analyzed by adopting Panse and Sukhatme (1978) [2] standard procedures.

Results and Discussion

Plant height and total no. of tillers

The data on plant height and No. of tillers per meter at different growth stages of rice and ragi crop were presented in [Table-1 to 4]. The Application of 50 % RDF + FYM @ 10 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1} recorded the highest plant height at 30 DAT, 60 DAT, 90 DAT and harvest stages of *kharif* rice but it was statistically on par with T_3 *i.e*., 125% RDF. During *rabi* ragi, the residual fertility and fertiliser levels had a significant influence on the plant height in the study.

Table-1 *Plant height (cm) at different stages of kharif rice as influenced by nutrient management interventions*

Treatment	2017				2018				Pooled data			
	30 DAT	60 DAT	90 DAT	Harvest	30 DAT	60 DAT	90 DAT	Harvest	30 DAT	60 DAT	90 DAT	Harvest
T_1:100% RDF	47.8	72.7	87.2	90.1	50.9	70.0	88.5	91.1	49.3	71.3	87.8	90.6
T_2 :100% RDF+ $ZnSO_4$ @ 50 kg ha^{-1}	50.2	79.1	93.5	96.9	52.5	81.5	91.3	94.6	51.3	80.3	92.4	95.7
T_3: 125% RDF+ $ZnSO_4$ @ 50 kg ha^{-1}	56.6	84.2	97.3	101.1	61.9	87.4	99.2	100.7	59.2	85.8	98.2	100.9
T_4: 75% RDF+ PM @ 0.82 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}	51.6	74.1	86.7	95.4	54.3	79.8	92.1	97.9	52.9	76.9	89.4	96.6
T_5:75% RDF+ FYM @ 5.0 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}	51.1	79.0	90.6	97.3	56.7	82.9	92.8	98.9	53.9	80.9	91.7	98.1
T_6: 50% RDF+ PM @1.6 t ha^{-1}+ $ZnSO_4$ @ 50kg ha^{-1}	50.8	73.9	91.9	95.0	52.1	79.0	93.8	99.3	51.4	76.4	92.8	97.1
T_7: 50% RDF+ FYM @ 10 t ha^{-1}+ $ZnSO_4$ @ 50 kg ha^{-1}	61.3	85.6	102.1	104.4	63.7	91.9	102.6	106.2	62.5	88.7	102.3	105.3
S.Em ±	2.75	1.83	2.54	1.86	2.47	2.98	3.01	1.82	2.61	2.40	2.77	1.84
CD (P=0.05)	8.2	5.5	7.6	5.6	7.4	8.9	9.0	5.4	7.8	7.2	8.3	5.5
CV (%)	11.6	5.2	6.1	4.2	9.8	8.1	7.1	4.1	10.7	6.6	6.6	4.1

Table-2 *Total Number of tillers m^{-2} at different stages of kharif rice as influenced by nutrient management interventions*

Treatment	2017				2018				Pooled data			
	30 DAT	60 DAT	90 DAT	Harvest	30 DAT	60 DAT	90 DAT	Harvest	30 DAT	60 DAT	90 DAT	Harvest
T_1:100% RDF	334	383	365	324	314	391	358	305	324	387	361	314
T_2 :100% RDF+ $ZnSO_4$ @ 50 kg ha^{-1}	342	385	373	349	359	398	367	320	350	391	370	334
T_3: 125% RDF+ $ZnSO_4$ @ 50 kg ha^{-1}	374	428	394	384	394	437	392	368	384	432	393	376
T_4: 75% RDF+ PM @ 0.82 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}	322	385	387	354	340	405	371	344	331	395	379	349
T_5:75% RDF+ FYM @ 5.0 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}	335	382	379	362	352	394	380	350	343	388	379	356
T_6: 50% RDF+ PM @1.6 t ha^{-1}+ $ZnSO_4$ @ 50kg ha^{-1}	352	388	380	357	366	407	381	362	359	397	381	359
T_7: 50% RDF+ FYM @ 10 t ha^{-1}+ $ZnSO_4$ @ 50 kg ha^{-1}	403	466	432	406	407	472	419	398	405	469	426	402
S.Em ±	15.14	14.54	16.62	15.13	12.77	14.04	13.88	9.07	13.95	14.29	15.25	12.10
CD (P=0.05)	45.4	43.6	49.8	45.3	38.2	42.1	41.6	27.2	41.8	42.8	45.7	36.2
CV (%)	9.5	8.0	9.5	9.2	7.8	7.5	8.1	5.7	8.6	7.7	8.8	7.4

Table-3 *Plant height (cm) at different stages of no till rabi ragi as influenced by nutrient management interventions*

Treatment	2017-18				2018-19				Pooled data			
	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest
Residual effect of nutrient interventions imposed to *kharif* rice												
T_1	48.2	64.9	84.1	90.8	50.9	67.8	86.8	93.3	49.5	66.3	85.4	92.0
T_2	48.7	64.8	85.6	92.5	52.3	69.6	88.2	95.1	50.5	67.2	86.9	93.8
T_3	49.8	67.5	85.8	93.5	52.7	69.8	87.3	96.0	51.2	68.6	86.5	94.7
T_4	49.4	66.8	91.0	96.0	53.4	70.1	91.6	97.0	51.4	68.4	91.3	96.5
T_5	50.2	70.1	93.0	97.9	54.0	70.0	95.0	99.0	52.1	70.0	94	98.4
T_6	50.1	68.5	94.5	98.8	53.9	71.9	96.5	99.0	52	70.2	95.5	98.9
T_7	51.3	71.0	96.6	102.2	56.2	72.7	99.0	102.0	53.7	71.8	97.8	102.1
SEm ±	0.14	0.7	1.17	1.0	0.9	0.60	1.2	0.8	0.52	0.65	1.18	0.9
CD (p=0.05)	0.4	2.2	3.6	3.1	2.8	2.1	3.7	2.5	1.6	2.1	3.6	2.8
CV (%)	8.2	8.9	9.6	10.2	6.0	9.7	8.6	9.3	7.1	9.3	9.1	9.7
Fertilizer doses applied to ragi												
S_1	43.8	61.5	81.8	89.9	46.8	65.9	83.4	91.7	45.3	63.7	82.6	90.8
S_2	53.4	73.5	100.0	104.1	58.0	75.1	101.4	104.5	55.7	74.3	100.7	104.3
S_3	51.6	68.9	91.1	96.3	55.0	71.0	93.5	97.7	53.3	69.95	92.3	97
S_4	49.8	66.8	87.6	93.4	53.0	69.2	90.4	96.2	51.4	68	89	94.8
SEm ±	0.19	0.7	0.8	0.66	0.4	0.7	0.8	0.6	0.295	0.7	0.8	0.63
CD (p=0.05)	0.5	2.2	2.5	1.9	1.3	2.1	2.3	1.7	0.9	2.15	2.4	1.8
CV (%)	8.7	7.9	6.9	10.5	9.5	9.9	8.5	7.9	9.1	8.9	7.7	9.2
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: S_1: No fertilizer; S_2: 100 % RDF (30-30-20 kg NPK ha^{-1}), S_3: 75 % RDF; S_4: 50 % RDF

Among the fertilizer levels applied in *rabi* ragi, S2 (100% RDF) recorded significantly highest plant height of ragi in the both the years of study and in pooled data. The increase in plant height in all the growth stages in both the years with T_7 treatment might be due to 50 % chemical fertilizers which are readily available nutrients to the plant height improvement in initial stages of crop growth and later, applied FYM might have contributed to the slow release of nutrients along with the chemical fertilizers which were applied as 3 split doses in the crop growth. Integrated nutrient management practices in rice may be ascribed to the better macro and micronutrient availability as well as improvement in the physical condition of the soil and also the strong root system was responsible to supply oxygenated energy for production of tillers and their growth through significant uptake of nutrients resulting into luxurious vegetative growth which in turn increase the plant height and total tillers in rice and ragi. These results are conformity with the, Kichu *et al*., (2016) [3], Masebo and Menabo (2016) [4], Singh *et al.,* (2016) [5], Kumar *et al.* (2017a) [6], Singh and Singh, (2018) [7].

Leaf Area Index

Data on LAI presented in [Table-6]. LAI was increases as growth advances and reaches a maximum at around heading. After heading, however, LAI declines as the lower leaves die but it is more than initial stages of crop growth but lower than at heading stage. Significantly highest LAI was recorded with T_3 *i.e.* 125% RDF + $ZnSO_4$ @ 50 kg ha^{-1} during all the growth stages from 30 DAT to 90 DAT over the rest of the treatments. However, at the harvesting stage, LAI values irrespective of the treatments statistically remained on par with each other during both the years of study. Highest LAI in T_3 is might be due to sufficient availability of N through chemical fertilizers which helps in vigorous growth of leaves and foliage. Since a greater number of leaves with expanded leaf blades are produced, hence LAI also increased. In the present study also a greater number of leaves were recorded with the T_3 treatment hence, leaf area index was also higher in this treatment. These present results are in agreement with the findings of Geetha and Balasubramaniyan, (2016) [8] and Premalatha and Angadi (2017) [9].

Table-4 *Total no. of tillers per m² at different stages of no till rabi ragi as influenced by nutrient management interventions*

Treatment	2017-18				2018-19				Pooled data			
	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest
Residual effect of nutrient interventions imposed to *kharif* rice												
T_1	53.3	58.1	56.4	55.2	54.1	59.1	58.0	57.0	53.7	58.6	57.2	56.1
T_2	53.6	58.5	57.3	55.9	55.4	60.6	58.7	57.5	54.5	59.5	57.7	56.7
T_3	53.9	59.8	57.9	56.4	55.1	61.4	59.4	57.9	54.5	60.6	58.6	57.1
T_4	55.4	60.4	58.4	57.0	52.7	62.0	59.6	58.5	54.0	56.5	59.0	57.7
T_5	57.0	63.5	61.5	60.5	58.5	65.5	63.2	61.6	57.7	64.5	62.3	61.0
T_6	55.9	62.1	60.3	58.7	57.3	64.3	62.3	60.2	56.6	63.2	61.3	59.4
T_7	58.5	65.5	63.4	61.9	60.5	66.7	65.0	61.2	59.5	66.1	62.8	61.5
SEm ±	0.54	0.76	0.56	0.60	1.89	0.67	0.52	0.60	1.21	0.71	0.54	0.60
CD (p=0.05)	1.6	2.3	1.7	1.8	5.8	2.1	1.6	1.8	3.7	2.2	1.6	1.8
CV (%)	8.0	9.2	6.2	8.6	8.1	8.3	5.8	7.9	8.0	8.7	6.0	8.2
Fertilizer doses applied to ragi												
S_1	52.8	57.9	56.3	55.0	51.9	59.3	58.3	56.5	52.3	58.6	57.8	55.7
S_2	60.2	66.7	64.4	63.1	61.0	68.3	65.8	63.1	60.6	67.5	65.1	63.1
S_3	54.8	60.7	59.0	57.7	56.2	62.5	60.5	59.3	55.5	61.6	59.7	58.5
S_4	53.7	59.3	57.5	56.5	55.5	61.1	59.1	57.7	54.6	60.2	58.3	57.8
SEm ±	0.66	0.56	0.61	0.75	1.30	0.60	0.62	0.72	0.98	0.58	0.61	0.73
CD (p=0.05)	1.9	1.6	1.7	2.1	3.7	1.7	1.7	2.1	2.8	1.6	1.7	2.1
CV (%)	7.6	8.7	9.4	5.9	10.6	10.5	12.5	11.1	9.1	9.6	10.9	8.5
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: S_1: No fertilizer; S_2: 100 % RDF (30-30-20 kg NPK ha^{-1}), S_3: 75 % RDF; S_4: 50 % RDF

Table-5 *LAI at different stages of kharif rice as influenced by nutrient management interventions*

Treatment	2017				2018				Pooled data			
	30 DAT	60 DAT	90 DAT	Harvest	30 DAT	60 DAT	90 DAT	Harvest	30 DAT	60 DAT	90 DAT	Harvest
T_1:100% RDF	1.73	3.49	4.20	3.53	1.83	3.69	4.30	3.20	1.78	3.59	4.25	3.36
T_2 :100% RDF+ $ZnSO_4$ @ 50 kg ha^{-1}	1.80	3.55	4.30	3.67	2.00	3.83	4.40	3.57	1.90	3.75	4.35	3.62
T_3: 125% RDF+ $ZnSO_4$ @ 50 kg ha^{-1}	2.23	4.07	4.63	3.70	2.60	4.27	4.87	3.73	2.41	4.17	4.75	3.71
T_4: 75% RDF+ PM @ 0.82 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}	1.22	3.06	4.10	3.15	1.50	3.30	3.93	3.03	1.36	3.18	4.01	3.09
T_5:75% RDF+ FYM @ 5.0 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}	1.40	3.37	3.93	3.20	1.63	3.50	4.23	3.27	1.51	3.43	4.08	3.23
T_6: 50% RDF+ PM @1.6 t ha^{-1}+ $ZnSO_4$ @ 50kg ha^{-1}	1.37	3.00	3.80	3.23	1.37	3.43	4.07	3.10	1.37	3.21	3.93	3.16
T_7: 50% RDF+ FYM @ 10 t ha^{-1}+ $ZnSO_4$ @ 50 kg ha^{-1}	1.57	3.40	4.17	3.40	1.73	3.60	4.30	3.50	1.65	3.50	4.23	3.45
S.Em ±	0.15	0.16	0.10	0.30	0.16	0.08	0.13	0.17	0.15	0.12	0.11	0.23
CD (P=0.05)	0.4	0.5	0.3	NS	0.5	0.3	0.4	0.5	0.45	0.4	0.3	0.7
CV (%)	12.2	11.0	5.4	10.1	10.4	5.5	7.0	11.8	11.3	8.2	6.2	10.9

Table-6 *SPAD meter reading at different stages of kharif rice as influenced by nutrient management interventions*

Treatment	2017			2018			Pooled data		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T_1:100% RDF	30.1	31.0	29.23	31.2	32.0	28.67	30.6	31.5	28.95
T_2 :100% RDF+ $ZnSO_4$ @ 50 kg ha^{-1}	31.5	32.2	29.27	33.1	33.3	29.43	32.3	32.7	29.35
T_3: 125% RDF+ $ZnSO_4$ @ 50 kg ha^{-1}	35.2	38.6	32.40	36.6	39.8	32.92	35.9	39.2	32.66
T_4: 75% RDF+ PM @ 0.82 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}	31.1	30.5	29.10	32.4	31.6	29.27	31.7	31.0	29.18
T_5:75% RDF+ FYM @ 5.0 t ha^{-1} + $ZnSO_4$ @ 50 kg ha^{-1}	30.9	31.3	29.20	32.5	32.4	29.63	31.7	31.8	29.41
T_6: 50% RDF+ PM @1.6 t ha^{-1}+ $ZnSO_4$ @ 50kg ha^{-1}	30.5	31.2	29.00	31.8	33.0	29.50	31.1	32.1	29.25
T_7: 50% RDF+ FYM @ 10 t ha^{-1}+ $ZnSO_4$ @ 50 kg ha^{-1}	32.6	32.3	29.50	33.4	34.3	30.10	33.0	33.3	29.80
S.Em ±	0.83	1.41	0.90	0.97	1.09	1.14	0.90	1.25	1.02
CD (P=0.05)	2.5	4.2	NS	2.9	3.2	NS	2.7	3.7	NS
CV (%)	5.8	9.6	6.8	6.6	7.1	8.5	6.2	8.3	7.5

SPAD Meter Reading

Data pertaining to chlorophyll content (SPAD reading) in leaves is presented in [Table-7]. Significantly highest chlorophyll content in leaves were recorded with 125% RDF along with 50 kg $ZnSO_4$ ha^{-1} (35.2 and 38.6) in 30, 60 DAT followed by 50 % RDF + FYM @ 10 t ha^{-1}+ $ZnSO_4$ @ 50 kg ha^{-1} (32.6 and 32.3). However, at 90 DAT the SPAD meter readings irrespective of treatments remained statistically on par with each other in both the years. In Samba mahsuri cultivar at 90 DAT means the crop at an age of 120 days (including nursery period) at this stage, crop is going to be harvested with in another 15-20 days so leaf chlorophyll content was decreased. The maximum chlorophyll content in leaf in T_3 treatment might be due to inorganic fertilizer nitrogen which inturn improved the chlorophyll content in the leaf by improving nutrient uptake by the plant. These results are inconformity with the findings of Siavoshi and Laware (2013)[10] and Prakash and Mahajan (2016) [11].

Conclusion

Overall, it can be concluded that the highest plant height, total No. of tillers per meter was recorded with the application of 50 % RDF + FYM 10 t ha^{-1} along with 50 kg zinc sulphate per hectare as soil application on rice whereas in LAI and SPAD reading highest in 125% RDF + $ZnSO_4$ @ 50 kg ha^{-1} and in *rabi* no till ragi, 50 % RDF + FYM 10 t ha^{-1} along with 50 kg zinc sulphate per hectare as soil application recorded maximum plant height and total No. of tillers per meter as residual effect and in fertilizer levels, 100 % RDF recoded significantly highest plant height and total No. of tillers per meter.

Application of research: Study of growth parameters of rice, zero till ragi

Research Category: Agronomy

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Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Agricultural College Farm, Bapatla

Cultivar / Variety / Breed name: Rice

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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