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ENHANCEMENT OF AGRO-MORPHOLOGICAL TRAITS OF RICE THROUGH GRADED LEVELS OF FERTILIZERS AND CO-COMPOST APPLICATION

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ABSTRACT

Field experiment was carried out during *Kuruvai* season (June – September, 2023) at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar – 608002, to evaluate the effect of graded levels of RDF with and without co-compost application on the growth characters of rice. The experiment was laid out in split plot design with three replications. The main treatment comprised of application of graded levels of recommended dose of fertilizers and sub plot treatments comprised of different co-compost application prepared from sugarcane trash, water hyacinth at 1:0, 0:1, 1:1, 2:1 and 1:2 proportion. The results of the experiment revealed that application of 125% recommended dose of fertilizer (M_4) significantly registered taller plant height at 30 DAT, 60 DAT and at harvest stage, maximum leaf area index at 30 DAT, dry matter production at 30 DAT, crop growth rate at 30 to 60 DAT. Contrastingly, application of 100% recommended dose of fertilizer (M_3) significantly resulted in maximum tiller number m^{-2} at 30 DAT, 60 DAT and harvest stage, leaf area index at 60 DAT, dry matter production at 60 DAT and at harvest stage and crop growth rate at 60 DAT to harvest stage, root length, root volume and root dry weight at 60 DAT. With respect to application of co-compost, application of co-compost (sugarcane trash: water hyacinth @ 1:1 ratio) @ 6.25 t ha^{-1} (S_4) registered significantly improved growth attributes of rice at all the stages of observation. Regarding the interaction effect, application of 125% recommended dose of fertilizer and co-compost (sugarcane trash : water hyacinth @ 1:1 ratio) @ 6.25 t ha^{-1} (M_4S_4) performed its superiority in registering higher plant height at 30 DAT, 60 DAT and harvest stage, maximum leaf area index at 30 DAT, dry matter production at 30 DAT and crop growth rate at 30 to 60 DAT. Contradictorily, application of 100% recommended dose of fertilizer and co-compost (sugarcane trash : water hyacinth @ 1:1 ratio) @ 6.25 t ha^{-1} (M_3S_4) was most effective method and resulted in higher values of tiller number m^{-2} at 30 DAT, 60 DAT and at harvest stage, leaf area index at 60 DAT, dry matter production at 60 DAT and at harvest stage and crop growth rate at 60 DAT to harvest stage, root length, root volume and root dry weight at 60 DAT. Based on the results of the present investigation, application of 100% recommended dose of fertilizer and co-compost (sugarcane trash : water hyacinth @ 1:1 ratio) @ 6.25 t ha^{-1} (M_3S_4) proved its superiority in registering higher growth characters in rice.

Key words : Co-compost, Growth characters, RDF, Rice, Sugarcane trash, Water hyacinth.

Introduction

Rice (*Oryza sativa* L.) is one of the most important food crops after wheat, consumed as a staple and an indispensable source of calories for almost half of the population everyday in Asia (Singh *et al*., 2020). Thus, paddy holds a prominent role in Indian agriculture, with India standing as the second-largest producer and consumer of rice on the global stage. Rice contributes 42 per cent of total food grain production and 45 per cent of cereal production. In India, it is cultivated across an area of 47.60 million hectares with a total production of 137.00 million metric tonnes and a productivity of 4.32 tonnes per hectare (USDA, 2024). In Tamil Nadu, rice is grown on 2.03 million hectares, with a production of 6.88 million tonnes and a productivity of 3.38 tonnes per hectare (Directorate of Economics and statistics, 2020-21).

Rice requires a high quantity of nutrients to achieve its potential yield. Under natural conditions, nutrients are recycled from plants to the soil to meet plant needs. Continues and indiscriminate use of inorganic fertilizers cannot sustain the soil fertility under intensive cropping and crop productivity under diversified continuous cropping or mono cropping as a result agriculture is now facing a lot of stresses (Kundu *et al*., 2010). Therefore, a suitable combination of organic and inorganic source of nutrients is necessary for sustainable agriculture that can improve growth characteristic of rice.

The macronutrients especially nitrogen, phosphorus and potassium (NPK) are classified as essential nutrients for growth and development of rice crops, without them the crop development is impaired. Nitrogen plays a major role in enhancing the yield of rice because of its fundamental role in biomass accumulation. Phosphorus is responsible for the development of root, ripening, early flowering and tolerance to specific biotic and abiotic stresses in rice. Potassium is an essential factor in optimizing root development, enhancing plant vigor, reducing lodging, encouraging cell division, supplying osmotic pull, helping to neutralize organic acid and boosting seed resistance to pests and diseases, helps in maintaining metabolism. Potassium is an essential factor in optimizing root development, enhancing plant vigor, reducing lodging, encouraging cell division, supplying osmotic pull, helping to neutralize organic acid and boosting seed resistance to pests and diseases, helps in maintaining metabolism. Therefore, combining NPK in fertilizing rice will definitely produce higher growth characteristics of rice. Co-composting is the controlled aerobic degradation of organics, using more than one feedstock. Results of several studies indicated that composting of water hyacinth with co-substrates such as poultry manure, rice straw, sawdust, biochar etc., hastened the composting process and reduced the nutrient losses (Beesigamukama *et al*., 2018a). Co-composting of water hyacinth and sugarcane trash may improve nutrient contents and thus the application of such compost might reduce chemical fertilizer requirement for crop production. Water hyacinth (*Eichhornia crassipes*) is a noxious aquatic weed, has a rich source of organic carbon and potassium (Gunnnarsson and Petersen, 2007), phosphorus and nitrogen (Sahu *et al*., 2002). Water hyacinth compost could then be added to soil as a source of organic NPK which are the most crop growth limiting plant nutrients (Wasonga *et al*., 2008). The sugarcane farmers disposed the trash by burning it in the field itself where the intensity of heat was created, it kills favourable soil microorganisms and also it depletes nutrients and organic carbon in the soil as well as creates environment threat (Mendoza, 2015). This trash is rich in nutrients, including 30.3% carbon, nitrogen, phosphorus and potash. The alternative use of burning of trash to create sugarcane trash compost enhance soil quality, crop growth, decrease waste, increase humus in the soil and minimize the environmental threats (Prasanthrajan *et al*., 2011). Therefore, the incorporation of sugarcane trash by composting has increased the organic carbon, available N, P and K. Integrated application of recommended dose of fertilizer and co-compost has been shown to minimize nutrient losses to the environment and effectively manage nutrient supply, resulting in improved growth characteristics of rice.

Materials and Methods

Field experiment was conducted at the Experimental Farm, Department of Agronomy, Annamalai University during the Kuruvai season (June – September, 2023). The Experimental Farm is geographically situated at $11^0 24'$ N latitude, $79^0 44'$ E longitude and at an altitude of +5.79 m above the mean sea level. The mean annual rainfall received at Annamalai Nagar was 1500 mm, distributed over 60 rainy days. Out of total rainfall, 1000 mm is received during North East monsoon, 400 mm is received during South West monsoon and 100 mm during hot weather period as summer showers. The amount of rainfall received during the cropping period was 387.6 mm in 21 rainy days. The soil of the experimental field was clay loam, with low in available N, medium in available P_2O_5 and high in available K_2O.

The short duration rice variety, ADT 43 was used as test crop and transplanted with a spacing of 15 × 10 cm. The experiment was laid out in split plot design with three replications. The main treatment comprised of graded levels of recommended dose of fertilizer *viz*., M_1 - 0% RDF, M_2 - 75% RDF (90:30:30 kg N, P_2O_5 & K_2O ha^{-1}), M_3 - 100% RDF (120:40:40 kg N, P_2O_5 & K_2O ha^{-1}) and M_{4-} - 125% RDF (150:50:50 kg N, P_2O_5 & K_2O ha^{-1}) and sub plot treatments treatment comprised of co-composts application such as S_1 - control, S_2 - sugarcane trash (100%) compost @ 6.25 t ha^{-1}, S_3 - water hyacinth (100%) compost @ 6.25 t ha^{-1}, S_4 - sugarcane trash : water hyacinth (1:1) co-compost @ 6.25 t ha^{-1}, S_5 - sugarcane trash : water hyacinth (2:1) co-compost @ 6.25 t ha^{-1} and S_6 - sugarcane trash : water hyacinth (1:2) co-compost @ 6.25 t ha^{-1}). Required quantity of co-composts were prepared and incorporated in the soil as per treatment schedule two weeks before transplanting of rice. The data on plant height, number of tillers, leaf area index, dry matter production, crop growth rate, root length, root volume and root dry weight were observed from the five tagged plants and the average values of each treatment were calculated and tabulated. The statistical analysis of the growth characteristics of rice field data was done as per the methodology given by Gomez and Gomez (2010). The critical differences were worked out at 5% probability level by using AGRES Statistical Software Version 3.01(AGRES, 1994), wherever the results were significant.

Results and Discussion

Growth characters

The observations recorded on plant height (cm), number of tillers m^{-2} and dry matter production (kg ha^{-1}) of rice obtained at various growth stages are tabulated in the Table 1.

Among the different levels of recommended dose of fertilizer application, the maximum plant height of 56.29, 77.06 and 104.94 cm at 30 DAT, 60 DAT and at harvest stage and dry matter production of 5529 kg ha^{-1} at 30 DAT were recorded in the application of 125% recommended dose of fertilizer (M_4). The increase in plant height at all stages and DMP of rice at 30 DAT owing to application of 125% RDF might be associated with stimulating effect of nitrogen levels on various physiological processes including hypertrophy and hyperplasia. These results are confirming the findings of Kumar *et al*. (1995), who reported an increase in plant height of rice on applying higher doses of nitrogenous fertilizer. Contrastingly, maximum tiller number m^{-2} at 427, 469 and 399 m^{-2} at 30 DAT, 60 DAT and at harvest stage and dry matter production 9303 and 11732 kg ha^{-1} at 60 DAT and at harvest stage, respectively were noticed with application of 100% recommended dose of fertilizer (M_3). This is because the recommended dose of fertilizer has adequate nutrient availability to the crop resulting in superior expression of tiller count and final dry matter accumulation as reported by Riste *et al*. (2017). Srivasta and Singh (2016) who also reported an increased number of tillers with the application of adequate amount of NPK fertilizer. The least plant height of 41.92, 62.97 and 86.56 cm at 30 DAT, 60 DAT and at harvest stage, tiller number of 296, 311 and 265 m^{-2} at 30 DAT, 60 DAT and at harvest stage, dry matter production of 2924, 5095 and 6531 kg ha^{-1} were recorded at 30 DAT, 60 DAT and at harvest stage, leaf area index of 1.61 and 3.51 at 30 DAT and 60 DAT and crop growth rate of 7.24 and 4.78 g m^{-2} d^{-1} at 30 to 60 DAT and 60 DAT to harvest stage, respectively were recorded in the unfertilized plot (M_1).

Different ratio of co-compost application caused a significant effect on the growth characters of rice. Among the different types of co-compost application, co-compost of sugarcane trash : water hyacinth @ 1:1 ratio @ 6.25 t ha^{-1} (S_4) significantly registered maximum plant height of 53.23, 73.68 and 100.77 cm at 30 DAT, 60 DAT and at harvest stage, tiller number of 407, 428 and 368 m^{-2} at 30 DAT, 60 DAT and at harvest stage and dry matter production of 4943, 8379 and 10656 kg ha^{-1} at 30 DAT, 60 DAT and at harvest stage, respectively. Water hyacinth compost contains high amounts of N (1.8%), P (0.6%), K (4.9%), Ca (1.9%) and Mg (0.4%) that enhanced the nutritional status primarily NO_3, PO_4, Ca, K, Mg, S and micronutrients (Widjajanto *et al*., 2002) in the forms that are readily taken up by the plants which ultimately enhanced plant height and number of tillers $hill^{-1}$. Water hyacinth not only enhances the nutritive value of the final compost but also when blended in appropriate quantities with other farm wastes, can accelerate the degradation process and enhance the crop growth characteristics. This is in consistent with the findings of Beesigamukama *et al*. (2018a) and Hariyono *et al*. (2022). The least plant height of 44.08, 63.62 and 88.27 cm at 30 DAT, 60 DAT and at harvest stage, tiller number of 326, 331 and 285 m^{-2} at 30 DAT, 60 DAT and at harvest stage and dry matter production of 3260, 5939 and 7585 at 30 DAT, 60 DAT and at harvest stage, respectively were recorded with no manure applied plot (S_1).

Interaction between different levels of fertilizer and co-compost were significantly influenced the growth characters of rice at different stages of observation. Application of 125 % RDF along with the co-compost of sugarcane trash: water hyacinth @ 1:1 ratio @ 6.25 t ha-$^{-1}$ (M_4S_4) resulted significantly maximum plant height of 62.21, 83.66 and 113.16 cm at 30 DAT, 60 DAT and at harvest stage, respectively and dry matter production of 6654 kg ha^{-1} at 30 DAT. Contrastingly, the maximum tiller number of 481, 537 and 445 m^{-2} at 30 DAT, 60 DAT and at harvest stage and higher dry matter production of 10960 and 13695 kg ha^{-1} at 60 DAT and at harvest stage, respectively. This could be ascribed to the slow and steady rate of nutrients released into the soil solution to match the required absorption pattern of rice might have promoted its translocation from source to sink resulting in improved growth characters. Due to the release of adequate amount of nutrients and more uptake of nutrient by crop which resulted in better root development and growth of plant leading to higher plant height, tiller count and dry matter accumulation. This is in accordance with

Table 1 : Effect of graded levels of RDF and co-compost application on the growth characters of rice.

Treatments	Plant height (cm)			Number of tillers m^{-2}			Dry matter production (kg ha^{-1})		
	30 DAT	60 DAT	Harvest Stage	30 DAT	60 DAT	Harvest Stage	30 DAT	60 DAT	Harvest Stage
Level of RDF									
M_1	42.16	61.59	85.73	296	311	265	2924	5095	6531
M_2	48.53	68.25	94.11	361	378	329	4035	7366	9648
M_3	52.98	73.40	100.42	427	469	399	4911	9303	11732
M_4	56.29	77.06	104.94	414	419	369	5529	8457	10782
S.Ed	**0.41**	**0.47**	**0.59**	**2.66**	**2.87**	**2.54**	**41.01**	**71.23**	**91.20**
CD (p=0.05)	**1.01**	**1.15**	**1.43**	**6.51**	**7.01**	**6.22**	**100.35**	**174.31**	**223.17**
Co-Compost Application									
S_1	44.08	63.62	88.27	326	331	285	3260	5939	7585
S_2	50.35	70.57	96.84	374	393	344	4434	7681	9851
S_3	51.24	71.37	97.97	394	412	354	4576	7927	10163
S_4	53.23	73.68	100.77	407	428	368	4943	8379	10656
S_5	50.48	70.59	96.93	377	399	345	4440	7694	9880
S_6	50.55	70.62	97.01	381	403	347	4445	7713	9907
S.Ed	**0.62**	**0.70**	**0.88**	**4.00**	**4.30**	**3.81**	**61.51**	**106.85**	**136.80**
CD (p=0.05)	**1.25**	**1.42**	**1.78**	**8.07**	**8.69**	**7.71**	**124.33**	**215.95**	**276.50**
Interaction Effects									
M_1S_1	39.52	58.96	82.36	276	283	237	2518	4475	5531
M_1S_2	42.41	62.1	86.23	292	308	268	2986	5186	6649
M_1S_3	42.82	62.14	86.48	304	321	273	3015	5236	6768
M_1S_4	42.86	62.15	86.57	306	322	274	3021	5250	6794
M_1S_5	42.59	62.07	86.34	297	314	269	2996	5205	6710
M_1S_6	42.75	62.12	86.42	301	317	271	3007	5219	6736
M_2S_1	45.46	65.15	89.97	329	342	299	3492	6398	8198
M_2S_2	48.45	68.21	94.13	361	376	329	4051	7434	9797
M_2S_3	48.75	68.27	94.23	370	391	333	4062	7493	9880
M_2S_4	51.18	71.37	97.92	372	393	352	4492	7935	10326
M_2S_5	48.63	68.24	94.17	365	381	330	4055	7449	9824
M_2S_6	48.68	68.26	94.22	367	387	332	4058	7487	9867
M_3S_1	45.63	65.17	90.32	341	351	303	3513	6449	8335
M_3S_2	53.78	74.39	101.52	428	467	404	5082	9386	11832
M_3S_3	53.98	74.45	101.82	455	506	429	5090	10227	12825
M_3S_4	56.68	77.55	105.42	481	537	445	5605	10960	13695
M_3S_5	53.86	74.43	101.65	427	475	405	5085	9395	11846
M_3S_6	53.93	74.42	101.76	432	478	407	5088	9402	11861
M_4S_1	45.7	65.21	90.43	358	348	300	3516	6434	8278
M_4S_2	56.75	77.59	105.48	414	421	376	5617	8716	11125
M_4S_3	59.4	80.61	109.36	425	430	380	6138	8750	11179
M_4S_4	62.21	83.66	113.16	446	461	402	6654	9372	11808
M_4S_5	56.82	77.63	105.56	419	425	377	5623	8727	11141
M_4S_6	56.84	77.66	105.62	423	428	378	5627	8743	11163
M at S									
S.Ed	**1.20**	**1.37**	**1.71**	**7.76**	**8.35**	**7.41**	**119.56**	**207.98**	**265.90**
CD (p=0.05)	**2.49**	**2.83**	**3.54**	**16.07**	**17.30**	**15.35**	**247.64**	**430.14**	**550.74**
S at M									
S.Ed	**1.24**	**1.40**	**1.76**	**7.98**	**8.60**	**7.62**	**123.03**	**213.70**	**273.61**
CD (p=0.05)	**2.50**	**2.84**	**3.55**	**16.14**	**17.37**	**15.41**	**248.65**	**431.91**	**553**

findings of Puli *et al*. (2014) and Obondo *et al*. (2021). Additionally, co-compost application might have improved soil aggregation, increased nutrient availability and created more favourable soil conditions. Consequently, these improvements would have enhanced physiological activities, improved light interception by the plants and resulted in greater vegetative growth and dry matter accumulation. Similar observations were made by Ramesh *et al*. (2011) and Siddaram *et al*. (2011). The least growth characters were registered in the absolute control i.e without fertilizers and co-compost application (M_1S_1).

Physiological characters

The observations recorded on leaf area index and crop growth rate (g m^{-2} d^{-1}) of rice obtained at various growth stages are tabulated in the Table 2.

Among the different levels of recommended dose of fertilizer application, the maximum leaf area index of 3.00 at 30 DAT and maximum crop growth rate of 12.58 g m^{-2} d^{-1} at 30 to 60 DAT, respectively were recorded in the application of 125% recommended dose of fertilizer (M_4). Furthermore, significant improvement in growth parameters with 100% RDF might be due to increased availability of nitrogen, phosphorus and potassium at balanced manner in the soil solution and its uptake by plant increased the metabolic activity and formation of meristematic tissues which improved the cell elongation and cell division which is turn improved the physiological traits of rice. Similar findings were also reported by Bahuguna *et al*. (2023) and Diwedi *et al*. (2024). The least leaf area index of 1.61 and 3.51 at 30 DAT and 60 DAT and crop growth rate of 7.24 and 4.78 g m^{-2} d^{-1} at 30 to 60 DAT and 60 DAT to harvest stage, respectively were recorded in the unfertilized plot (M_1).

Different ratio of co-compost application caused a significant effect on the growth characters of rice. Among the different types of co-compost application, co-compost of sugarcane trash: water hyacinth @ 1:1 ratio @ 6.25 t ha^{-1} (S_4) significantly registered maximum leaf area index of 2.70 and 5.12 at 30 and 60 DAT and crop growth rate of 11.45 and 7.59 g m^{-2} d^{-1} at 30 to 60 DAT and 60 DAT to harvest stage. Water hyacinth compost contains high amounts of N (1.8%), P (0.6%), K (4.9%), Ca (1.9%) and Mg (0.4%) that enhanced the nutritional status primarily NO_3, PO_4, Ca, K, Mg, S and micronutrients (Widjajanto *et al*., 2002) in the forms that are readily taken up by the plants which ultimately enhanced plant height and number of tillers $hill^{-1}$. Water hyacinth not only enhances the nutritive value of the final compost but also when blended in appropriate quantities with other farm

Table 2 : Effect of graded levels of RDF and co-compost application on the physiology of rice.

Treatments	Leaf area index		Crop growth rate (g m^{-2} d^{-1})	
	30 DAT	60 DAT	30 to 60 DAT	60 to harvest stage
Level of RDF				
M_1	1.61	3.51	7.24	4.78
M_2	2.31	4.39	11.1	7.61
M_3	2.91	5.58	11.82	8.10
M_4	3.00	5.07	12.58	7.75
S.Ed	**0.03**	**0.06**	**0.08**	**0.05**
CD (p=0.05)	**0.07**	**0.14**	**0.19**	**0.12**
Co-Compost Application				
S_1	1.81	3.77	8.93	5.48
S_2	2.53	4.68	10.82	7.23
S_3	2.6	4.82	11.17	7.45
S_4	2.7	5.12	11.45	7.59
S_5	2.55	4.7	10.85	7.29
S_6	2.57	4.71	10.89	7.31
S.Ed	**0.04**	**0.08**	**0.12**	**0.08**
CD (p=0.05)	**0.09**	**0.17**	**0.24**	**0.16**
Interaction Effects				
M_1S_1	1.37	3.18	6.52	3.47
M_1S_2	1.61	3.55	7.33	4.88
M_1S_3	1.68	3.59	7.4	5.11
M_1S_4	1.7	3.6	7.43	5.15
M_1S_5	1.64	3.57	7.36	5.02
M_1S_6	1.65	3.56	7.37	5.06
M_2S_1	1.93	3.95	9.69	6
M_2S_2	2.26	4.37	11.28	7.88
M_2S_3	2.36	4.42	11.44	7.96
M_2S_4	2.72	4.81	11.48	7.97
M_2S_5	2.29	4.39	11.31	7.92
M_2S_6	2.32	4.41	11.43	7.93
M_3S_1	1.96	3.99	9.74	6.29
M_3S_2	3.07	5.63	12.11	8.15
M_3S_3	3.12	6.05	12.2	8.66
M_3S_4	3.14	6.46	12.56	9.12
M_3S_5	3.08	5.65	12.14	8.17
M_3S_6	3.1	5.67	12.18	8.2
M_4S_1	1.98	3.97	9.78	6.15
M_4S_2	3.17	5.18	12.56	8.03
M_4S_3	3.22	5.22	13.63	8.1
M_4S_4	3.25	5.62	14.35	8.12

Table 2 continued...

Table 2 continued...

M_4S_5	3.18	5.19	12.57	8.05
M_4S_6	3.21	5.21	12.58	8.07
M at S				
S.Ed	**0.09**	**0.16**	**0.23**	**0.15**
CD (p=0.05)	**0.18**	**0.34**	**0.48**	**0.31**
S at M				
S.Ed	**0.09**	**0.17**	**0.24**	**0.15**
CD (p=0.05)	**0.18**	**0.34**	**0.48**	**0.31**

wastes, can accelerate the degradation process and enhance the crop growth characteristics. This is in consistent with the findings of Beesigamukama *et al*. (2018a) and Hariyono *et al*. (2022). The least leaf area index of 1.81 and 3.77 at 30 and 60 DAT and crop growth rate of 8.93 and 5.48 g m^{-2} d^{-1} at 30 to 60 DAT and 60 DAT to harvest stage, respectively were recorded with no manure applied plot (S_1).

Interaction between different levels of fertilizer and co-compost were significantly influenced the growth characters of rice at different stages of observation. Application of 125 % RDF along with the co-compost of sugarcane trash: water hyacinth @ 1:1 ratio @ 6.25 t ha-$^{-1}$ (M_4S_4) resulted significantly maximum leaf area index of 3.25 at 30 DAT and crop growth rate of 14.35 g m^{-1} d^{-1} at 30 to 60 DAT. Contrastingly, the maximum leaf area index of 6.46 at 60 DAT and crop growth rate of 9.12 g m^{-1} d^{-1} 60 DAT to at harvest stage. This could be ascribed to the slow and steady rate of nutrients released into the soil solution to match the required absorption pattern of rice might have promoted its translocation from source to sink resulting in improved growth characters. This is in accordance with findings of Puli *et al*. (2014) and Obondo *et al*. (2021). Additionally, co-compost application might have improved soil aggregation, increased nutrient availability and created more favourable soil conditions. Consequently, these improvements would have enhanced physiological activities, improved light interception by the plants and resulted in greater vegetative growth and dry matter accumulation. Similar observations were made by Ramesh *et al*. (2011) and Siddaram *et al*. (2011). The least growth characters were registered in the absolute control *i.e* without fertilizers and co-compost application (M_1S_1).

Root characters

The data recorded on root length (cm), root volume (cc $hill^{-1}$) and root dry weight (g $hill^{-1}$) observed at 60 DAT of rice are given in Table 3. Significant effect on root characters of rice was noticed as a result of co-compost and different levels of fertilizers.

Table 3 : Effect of graded levels of RDF and co-compost application on the root characters of rice.

Treatments	**Root length (cm)**	**Root volume (cc $hill^{-1}$)**	**Root dry weight (g $hill^{-1}$)**
	60 DAT	**60 DAT**	**60 DAT**
Level of RDF			
M_1	17.07	18.76	3.99
M_2	20.5	22.13	4.43
M_3	24.82	26.31	5.05
M_4	23.02	24.53	4.77
S.Ed	**0.20**	**0.22**	**0.03**
CD (p=0.05)	**0.49**	**0.53**	**0.06**
Co-Compost Application			
S_1	18.08	19.71	4.13
S_2	21.58	23.14	4.58
S_3	22.05	23.62	4.66
S_4	23.12	24.7	4.8
S_5	21.64	23.19	4.59
S_6	21.66	23.22	4.6
S.Ed	**0.30**	**0.32**	**0.04**
CD (p=0.05)	**0.61**	**0.66**	**0.08**
Interaction Effects			
M_1S_1	15.6	17.25	3.82
M_1S_2	17.28	18.96	4
M_1S_3	17.4	19.11	4.02
M_1S_4	17.41	19.13	4.05
M_1S_5	17.37	19.02	4.03
M_1S_6	17.38	19.06	4.01
M_2S_1	18.86	20.48	4.21
M_2S_2	20.48	22.12	4.42
M_2S_3	20.59	22.22	4.46
M_2S_4	21.99	23.62	4.64
M_2S_5	20.54	22.15	4.41
M_2S_6	20.55	22.18	4.45
M_3S_1	18.93	20.57	4.25
M_3S_2	25.07	26.52	5.07
M_3S_3	26.59	28.05	5.28
M_3S_4	28.09	29.55	5.48
M_3S_5	25.11	26.58	5.09
M_3S_6	25.13	26.6	5.1
M_4S_1	18.92	20.52	4.24
M_4S_2	23.49	24.97	4.83
M_4S_3	23.6	25.11	4.86
M_4S_4	25	26.51	5.03
M_4S_5	23.54	25.02	4.82
M_4S_6	23.58	25.05	4.85

Table 3 continued...

Table 3 continued...

M at S			
S.Ed	**0.59**	**0.63**	**0.07**
CD (p=0.05)	**1.21**	**1.30**	**0.15**
S at M			
S.Ed	**0.60**	**0.65**	**0.08**
CD (p=0.05)	**1.22**	**1.31**	**0.15**

Among the different levels of recommended dose of fertilizer, the maximum root length of 24.82 cm, root volume of 26.31 cc hill^{-1} and root dry weight of 5.05 g hill^{-1} at 60 DAT were noticed with the application of 100% RDF (M3). This might be due to the adequate amount of RDF application, which led to higher phosphorus uptake by the crop, attributed to increased phosphorus availability and enhanced root growth. These results are confirmed by the finding of Yosef Tabar (2012). The least root length of 17.07 cm, root volume of 18.76 cc hill^{-1} and root dry weight of 3.99 g hill^{-1} at 60 DAT were recorded in the application of 0% recommended dose of fertilizer (M_1).

Regarding the co-compost application, application of co-compost of sugarcane trash: water hyacinth @ 1:1 ratio @ 6.25 t ha^{-1} (S_4) registered a higher root length of 23.12 cm, root volume of 24.70 cc hill^{-1} and root dry weight of 4.80 g hill^{-1} at 60 DAT. This might be due to co-compost contains high amount of organic matter which could have increased the moisture retention of soil, improved dissolution of nutrients particularly phosphorus and soil structure hence better root growth as reported by Obondo *et al*. (2021) and Beesigamukama *et al*. (2018b). The least root length of 18.08 cm, root volume of 19.71 cc hill^{-1} and root dry weight of 3.82 g hill^{-1} at 60 DAT was noticed with absolute control (M_1S_1).

With respect to interaction effect, maximum root length of 28.09 cm, root volume of 29.55 cc hill^{-1} and root dry weight of 5.48 g hill^{-1} at 60 DAT were noticed under application of 100% RDF along with co-compost of sugarcane trash: water hyacinth @ 1:1 ratio @ 6.25 t ha^{-1} (M_3S_4). This might be due to application of plant-based compost significantly improved the soil physical condition which might have provided a better soil environment for root development. This was evidenced earlier by Arancon *et al*. (2006), Holah *et al*. (2012) and Rajiv and Vanathi (2018). The least root length of 15.60 cm, root volume 17.25 cc hill^{-1} and root dry weight of 3.82 g hill^{-1} at 60 DAT was registered with absolute control (M_1S_1).

Conclusion

From the enlightenment of the studies, the balanced nutrient profile and organic matter from the co-compost contributed to improved soil health and plant growth. It has been discovered that application of 100% recommended dose of fertilizer (120:40:40 kg N, P_2O_5 & K_2O ha^{-1}) and co-compost of sugarcane trash: water hyacinth @ 1:1 ratio @ 6.25 t ha^{-1} (M_3S_4) was highly impressive effective method for maximizing growth characteristics of rice.

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