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Compost Tea Improves Biomass, Yield and Induces a Defense Response in Rice *(Oryza sativa* L.) under Aerobic Cultivation

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ABSTRACT

In the current scenario of agriculture, agrochemical responsive crop cultivation has become common practice, to reap high produce from farming. However agrochemical usage is not a sustainable approach and also excessive use will deleteriously affect the environment. To combat the harmful effects of agrochemicals, there is a need to develop alternate organic or integrated approaches, compost tea being one such approach. To evaluate beneficial effects of compost tea on growth and yield of paddy we implemented compost tea treatments on four genotypes (ARB 6, BR2655, HR12 and KRH 4) of paddy in a field experiments under aerobic cultivation in the Kharif of 2017 at GKVK, Bangalore. The results showed that, there is a significant increase in plant height, number of productive tillers, chlorophyll content, plant biomass and grain yield both aerated and non-aerated compost tea treated plants than control plants. From the biochemical analyses show a significant induction of defense related enzymes such as Peroxidase and Superoxide dismutase in compost tea treated plants compared to controls. This increased defense related enzyme activity suggests that compost tea can play a role in inducing defense and thus can be potentially used in disease management in paddy. Collectively, these results suggest that compost tea can be a promising eco-friendly and an effective technology for increasing yield in paddy.

Keywords: *Compost tea, Peroxidase, Superoxide dismutase*

INTRODUCTION

Rice is the most important staple food crop in the world. Rice has shaped the culture, diets and economies of millions of people. Improving the production of rice is necessary to sufficiently feed the growing world population. In agriculture, heavy usage of chemicals to increase yield and to control pest and diseases is a common practice. Excessive use of agrochemicals has contributed to environmental pollution such as air pollution, water pollution, and soil pollution. To save the environment the development of alternative eco-friendly techniques such as compost tea which is easy to practice and safe to use is warranted.

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Compost is an organic matter that has been decomposed and recycled as fertilizer and Amendment. Compost tea (CT) is a watery suspension made by steeping compost in water and fermented under aerated or non aerated conditions. Two dominant approaches are being advocated in compost tea production. They are aerated and non aerated methods. Aerated compost tea (ACT) is made by keeping compost with water in the ratio of 1:10 with the supply of oxygen for one week where NCT is prepared in the same manner except the continuous oxygen supply.

The induction of host plant defense system is a promising strategy to reduce pesticide use in conventional agricultural practices, decreasing negative side effects on both the environment and human health. The basic principle of Induced systemic resistance (ISR) relies upon enhancing the resistance in the host plant in response to an extrinsic stimulus without altering the genome. ISR sometimes involves expression of pathogenesis related (PR) genes, production of defense-related enzymes such as β-1,3 glucanase, chitinase, superoxide dismutase (SOD) and peroxidase (POX); or accumulation of phytoalexin (Heil & Bostock, 2002). Compost watery extracts (CWEs) sprayed on pepper and cucumber plants were showed increased activity of defense enzymes *viz*., POX, β-1,3-glucanase, chitinase under pathogen-inoculated conditions (Sang & Kim, 2011). Compost tea foliar treatment was successful in suppressing late blight disease in potato crop (Anil et al., 2017a), with concomitant induction of SOD, POX and phenolic compounds in potato plants when exposed to compost tea (Anil, 2014, 2017a). Compost tea acts as a biofertiliser, as well as bioprotectant in muskmelon crop (Naidu et al., 2013). Anil and coworkers have identified the presence of microbially synthesized phytohormones such as auxin and gibberellins in both aerated and non aerated compost tea (Anil et al., 2017b), and also have demonstrated enhanced plant biomass and tuber yield in potato crop (Anil et al., 2017a) Thus compost tea application has been reported to enhance biomass and yield in plants (Kim et al., 2015; Anil et al., 2017a) and can potentially act as a plant growth promoter.

In view of the above, present study was conducted to evaluate the effect of compost tea on biomass, yield and induced defense in rice crop grown under aerobic cultivation condition.

MATERIALS AND METHODS

Field Experiment:

The field experiment was conducted during *Kharif* season of 2017 at GKVK campus, University of Agricultural Sciences, Bangalore. Four Rice Genotypes were selected for the field experiment *viz.*, ARB 6, KRH 4, BR2655 and HR12. The experiment was laid out in Factorial Randomized Complete Block Design (FRCBD) with 3 replications. Selected genotypes were grown in the field under aerobic cultivation practice. The field management was followed as per the recommended Package of Practice of UAS, Bangalore. Treatments used in the study are elaborated in Table1.

Table 1: Treatments used in the study:

Treatment Numbers	Treatments	Description
T1	Control	No fungicidal or biocontrol treatments
T2	Fungicide	Recommended fungicidal treatments, (Bavistin 1g/L, was sprayed twice)
T3	RF (Reduced Fungicide)	Reduced fungicidal treatments at disease incidence (Bavistin 1g/L, was sprayed once)
T4	Compost water	Freshly mixed Compost in water without fermentation
T5	10 NCT	Ten NCT foliar sprays from 30 days after sowing (DAS) distributed as two sprays per week for five weeks.

T6	5 NCT+RF+ST (with Seed treatment, ST)	Seeds are treated over night with NCT before sowing; Five sprays of NCT from 30 DAS distributed as one sprays per week for five weeks, plus one spray of fungicide at disease incidence.
T7	5 NCT+RF	Five sprays of NCT from 30 DAS distributed as one spray per week for five weeks, plus one spray of fungicide at disease incidence.
T8	10 NCT+RF	Ten sprays of NCT from 30 DAS distributed as two sprays per week for five weeks, plus one spray of fungicide at disease incidence.
T9	10 ACT	Ten ACT foliar sprays from 30 DAS distributed as two sprays per week for five weeks.
T10	5 ACT+RF+ST (with Seed treatment, ST)	Seeds are treated over night with ACT before sowing; Five sprays of ACT from 30 DAS distributed as one sprays per week for five weeks, plus one spray of fungicide at disease incidence.
T11	5 ACT+ RF	Five sprays of ACT from 30 DAS distributed as one spray per week for five weeks, plus one spray of fungicide at disease incidence.
T12	10 ACT+RF	Ten sprays of ACT from 30 DAS distributed as two sprays per week for five weeks, plus one spray of fungicide at disease incidence.

RF: Reduced Fungicide, CW: Compost water, ST: Seed treatment, NCT: Non-aerated Compost tea, ACT: Aerated Compost tea

Phenotypic Observations:

Phenotypic observations namely, plant height, number of productive tillers, grain yield per plant, biomass, etc., were recorded for five plants from each replication.

Chlorophyll Estimation:

Chlorophyll was extracted and estimated as per the method of Arnon (1994). Essentially chlorophyll was extracted from leaf samples using 80 % acetone and DMSO in the ratio of 1:1. Absorbance was determined at 663 nm and 645 nm using a UV - spectrophotometer. Using the molar absorption coefficient, the amount of chlorophyll is calculated.

Protein Extraction:

Leaves from different treatments were frozen in liquid nitrogen, to prevent proteolytic activity, and homogenized using a mortar and pestle. The homogenate was then suspended in extraction buffer [Phosphate buffer 0.1 M, pH 7.8, 1mM PMSF (protease inhibitor) and 0.1 % of poly vinyl pyrrolidone (PVP)] and kept on ice for 15 min. The crude protein extracts were centrifuged at 14,000 rpm at 4°C for 30 min. The pellet was discarded and the supernatant containing the soluble proteins was used for further experiments. Protein concentration was determined by the method of Lowry (Lowry et al., 1951) using BSA as standard.

Defense Enzyme assays:

Peroxidase enzyme activity in the protein extract was measured by the method proposed by Castillo et al. (1984) with slight modification. Peroxidase activity is assayed as increase in optical density due to the oxidation of guaiacol to tetra-guaiacol. Native PAGE was performed as the method described by Davis (1964) for peroxidase isoenzyme activity by using 10 % resolving gels and 5 % stacking gel. Protein extract (25 µg) of all genotypes and treatments were loaded in gel. Electrophoresis is performed initially at 60 volts and when the protein entered the resolving gel, the voltage was increased to 120. Electrophoresis was conducted at $4^{O}C$ for about 3 h. Later the gel was stained for peroxidase isoenzymes.

SOD activity was measured by the method described by Dhindsa et al., (1981) with slight modifications. SOD activity in the supernatant was assayed by its ability to inhibit photochemical reduction of nitro blue tetrazolium (NBT). Native PAGE was performed according to the method described by Davis (1964) for superoxide dismutase isoenzyme activity by using 5 % stacking gels and 10 % resolving gels. Protein extract (25 µg) from all genotypes and treatments were loaded to gel. Electrophoresis was performed initially at 60 volts and after the protein entered the resolving gel the voltage was increased to 120. The electrophoresis was conducted for 3 h at 4˚C. The gel was incubated in a staining solution containing 100 % NBT (w/v), 0.2M EDTA (w/v), 0.1M sodium phosphate buffer (pH 7.5), commercial grade TEMED and 5 % riboflavin (w/v) for 30 min until the bands appeared. The isoenzyme bands appeared as white/colourless in a dark blue background and the isoenzyme pattern was photographed.

RESULTS AND DISCUSSION

The field experiment taken up in the *Kharif* of 2017 with four rice genotypes under aerobic conditions showed clear variations in terms of biomass of plants, defense enzyme activity and the grain yield (Figure 1.a,b,c and d).

Effects of compost tea on biomass and vigor of the paddy crop

Compost tea treatments resulted in a significant higher plant height in all Rice genotypes as compared to the controls (Table 2). Highest plant height was recorded in 10 NCT+RF treatment in genotype HR 12 *i.e.*, 125.00 cm. In case of ARB 6, BR2655 and KRH 4 highest plant heights were recorded in 5 NCT+RF+ST (83.19 cm), 10 ACT+RF (100.57 cm) and 5 NCT+RF+ST (97.09 cm) treatments respectively. In ARB 6 both ACT and NCT treatments showed effective increase in plant height and were on par; treatments 5 NCT+RF+ST, 10 NCT+RF, 5 ACT+RF+ST and 10 ACT+RF showed on par results. In KRH 4 treatments 5 NCT+RF+ST and 5 ACT+RF+ST resulted in taller plants that were on par with each other.

Table 3 shows that both ACT and NCT treatments have shown significantly more plant dry weight compared to controls. Treatment 10 NCT (56.87 g) resulted in the highest dry weight in ARB 6 among the different compost tea treatments. In BR 2655, treatments, 10 NCT+RF and 5 ACT+RF+ST resulted in significantly higher Dry weight at 59.21g and 59.31 g compared to controls (28.10g) but were on par with each other. In HR 12 genotype, treatment 5 ACT+ RF (62.28 g) treatment showed significantly higher Dry weight as compared to other treatments. In KRH 4 genotype of rice, Compost tea induced significant enhancement of Dry weight, with highest value recorded in 5 NCT+RF+ST (78.66 g) and 10 NCT+RF (78.12 g). The data obtained in terms of dry weight, height of Plants and number of tillers (Data not shown) indicates that both aerated and non aerated compost tea treatments have a significant effect in enhancing the overall biomass of rice plants as compared to the controls under aerobic cultivation. Kim, et al., (2015) also reported that the increase of biomass in lettuce, soybean and sweet corn in CT treated plants. Presence of nitrates in the compost tea helps to increase the plant biomass. Anil et al., (2017a) for the first time reported the presence of both IAA and GA in fermented compost teas. The microbial biosynthesis of IAA and GA in fermented compost tea contributes to enhanced plant biomass under field conditions.

Chlorophyll from leaves of all the rice genotypes were extracted and estimated. The results reveal that compost tea sprays have enhanced chlorophyll content in all genotypes and clear significant difference was recorded in compost tea treatments as compared to the controls (Table 4). Highest Chlorophyll content was observed in treatment 10 NCT treatment (4.93 mg/g FW) in ARB 6 genotype among the compost tea treatments, and differed significantly from the control (3.33 mg/g FW). In BR2655 genotype 5 ACT+RF+ST and 5 NCT+RF+ST showed high chlorophyll content 4.41 mg/ g FW and 4.43 mg/ g FW respectively, but were on par with each other. In genotype HR 12, treatments 10 NCT+RF (4.50 mg/g FW) treatment showed highest Chlorophyll content than other treatments. In KRH 4 treatment 10 NCT, 5 NCT+RF+ST, 5 NCT+RF, 5 ACT+ RF and 10 ACT+RF treatments were high but on par with each other. In HR 12 Chlorophyll content in control was 2.83 mg/ g FW and highest value in 10 NCT+RF (4.50 mg/g FW) treatment leaves, so 37 % increase in chlorophyll content was observed in NCT treatment compared to control treatment. Both ACT and NCT treatments showed significant biomass increase along with significant increase in the chlorophyll content compare to controls. XU et al., (2012) reported that humic-like substances present in compost tea promoted plant N uptake and increased the chlorophyll content in cucumber plants.

Compost tea inducing defense priming:

The evaluation of defense priming among the treatments reveal that POX and SOD defense enzyme activities varied between the genotype and increased with compost tea treatments in all the genotypes. Thus in Rice plants all compost treatments of ACT and, NCT exhibits heightened defense preparedness as seen by enhanced POX and SOD activities, and thus is likely to contribute to induced defense. Compost tea treatment increased POX activity in all treatments across the genotypes (Fig.02a,). Leaves from all compost tea treatments across the rice genotypes showed significant enhancement in POX activity as compared to controls at 5 % level of significance (Table 5). In case of ARB 6 genotype, treatment 5ACT+ RF (373.95 µg/min/mg protein) showed significantly higher POX activity compared to other treatments. In BR 2655 genotype 5NCT+RF (397.83 µg/min/mg protein) treatment showed highest POX activity compared to other compost tea treatments. In HR 12 plants 5 NCT+ RF and 5 ACT+RF+ST treatments resulted in higher induction of POX and were on par with each other. In the hybrid KRH 4, treatment 5ACT+ RF (196.48 µg/min/mg protein) showed significantly higher POX activity compared to other compost tea treatments. Both 10 and 5 sprays of compost tea significantly enhanced POX activity and were comparable to each other, suggesting that the level of defense priming was comparable between ten number of sprays and five sprays. The peroxidase isoenzyme activity was analyzed in-gel by running native PAGE and the banding pattern of peroxidase isozymes varied among treatments (Fig.02b).

Superoxide dismutase activity was found to be higher among all the genotypes between compost treatments and controls (Fig.03a, Table 6). ACT and NCT treatments showed high SOD activity suggesting defense priming in the plants. In genotype BR2655 showed highest SOD activity *i.e.*, 9.68 µg protein/50 % inhibition as compared to control activity of 15.12 µg protein/50 % inhibition. In case of genotype ARB 6, treatment 5 ACT+ RF (9.67 µg protein /50 % inhibition), 5 ACT+RF+ST (10.15 µg protein /50 % inhibition) and 5NCT+ RF (10.23 µg protein/50 % inhibition) showed on par results, the activity being significantly higher than the control (15.12 µg protein/50 % inhibition). In genotype BR 2655 treatment 10 ACT+RF treatment showed significantly highest SOD activity (9.68 µg protein/50 % inhibition) compared to other treatments. In HR 12, treatments 5NCT+ RF (10.80 µg protein/50 % inhibition) and 5 ACT+RF (10.65 µg protein/50 % inhibition) showed on par results. In KRH 4 genotypes treatments 5NCT+ RF (12.19 µg protein/50 % inhibition) and 5 ACT+RF (12.74 µg protein/50 % inhibition) showed on par results. Both 10 and 5 sprays of compost tea significantly enhanced SOD activity and were comparable to each other, suggesting that the level of defense priming was comparable between ten number of sprays and five sprays. The SOD isoenzyme activity was analyzed in-gel by running native PAGE. The banding pattern of SOD isozymes varied among treatments (Fig.03b).

Sang & Kim (2011) investigated direct and indirect effect of compost watery extracts (CWEs) from different regions of Korea on control of anthracnose disease on pepper and cucumber and found increased peroxidase enzyme and hydrogen peroxide accumulation compared with controls. The authors suggest that compost tea induces systemic defense in plants. Anil and Co-workers also have biochemically evaluated compost tea induced defense priming in potato and have demonstrated the resulting Late blight suppression (Anil et al., 2017).

Compost tea enhances paddy yield parameters

Compost tea significantly increased yield parameters i.e., number of productive tillers and grain yield per plant in all rice genotypes (Tables 7 and 8). The recording of number of productive tillers per plant showed a significant difference between control and compost tea treated plants (Table 7). All genotypes responded to compost tea treatments and showed significantly higher NPT compared to controls. In ARB 6 plants 10 NCT (21.67) and 10 ACT+RF (20.11) showed high NPT, but were on par with each other. In genotype BR 2655 both treatments, NCT (16.78) and ACT (16.33) resulted in high NPT but were on par with each other. In HR 12, treatments 5 NCT+RF+ST (20.07) treatment showed highest NPT compared to other compost tea treatments. In genotype KRH 4, treatments 10 NCT+RF (20.22), 5 ACT+ RF (19.34) and 10 ACT+ RF (19.33) showed high NPT but were on par with each other. ARB 6 showed higher number of productive tillers i.e. 21.67 in 10 NCT treatment with control showing only 17 NPT. In case of BR 2655 NPT increased in all compost tea treatment up to 46 % as compared to control.

There is significant difference between the control and Compost tea treated plants with respect to grain yield per plants (Table 8). Both NCT and ACT treatments showed significantly higher grain weight per plant compared to controls. In genotype ARB 6, highest grain weight per plant was observed in 10 NCT (32.34 g). In BR 2655 genotype, treatments 10 NCT+RF (22.22 g), 5 ACT+RF+ST (22.31 g) and 5 ACT+ RF (22.31 g) showed high grain weight/ plant but were on par with each other. In HR 12, treatments 10ACT (23.88 g) and 5ACT+RF (24.21 g) showed on par results. In KRH 4 plants 5 NCT+RF+ST (35.21 g) treatment showed significantly more grain weight per plant than all other treatments. Compost tea treatment resulted in 25 to 30 % increased grain yield (grain weight per plant) compared to controls in all genotypes. KRH 4 genotype is a high yielding hybrid which showed significantly high yield compared to all other genotypes

Microbial communities present in compost tea stimulate nutrient uptake and plant growth which ultimately leads to yield enhancement (Ingham, 2005). The yield increase in compost tea treatments could be a combination of increased chlorophyll and biomass of plants. Similar kind of increased yield was noticed in potato crop (Anil et al., 2017b).

Control, fungicide, RF and CW were used as controls in the study. CW, freshly mixed compost in water is used as a spray. This treatment does not show any biomass enhancement in the plants indicating the importance of fermentation of the compost and water mixture for 4-7 days. In the absence of this fermentation step, the beneficial effects of the treatment were not observed. Earlier work showed RF alone was unable to control the disease, where combination of RF with CT could manage the disease in potato (Anil et al., 2014). So, combinations of CT and RF treatments were used in the study. Bavistin sprayed twice in fungicide treatment and once in RF treatment. But there was no disease observed in the field. So, effect of Fungicide and RF did not show much difference in the current study. All four controls showed comparable results which is significantly lesser than compost tea and compost tea combinations.

Table 2: Effect of compost tea treatments on Plant Height of rice plants in field experiment conducted in *Kharif* of 2017 at GKVK

	Treatments	Plant Height (cm)			
		ARB 6	**BR 2655**	**HR 12**	**KRH 4**
T1	Control	64.40	75.43	96.54	73.68
T2	Fungicide	73.44	80.86	96.18	75.66
T3	RF	64.51	78.33	96.67	74.67
T4	C W	65.44	74.86	102.67	74.54
T5	10 NCT	76.30	93.90	118.56	92.89
T6	5 NCT+RF+ST	83.19	92.56	115.33	98.32
T7	5 NCT+RF	80.77	97.11	112.77	94.11
T8	10 NCT+RF	82.66	92.30	111.67	83.79
T9	10 ACT	78.45	92.55	108.56	80.00
T10	5 ACT+RF+ST	82.96	93.51	111.68	96.55
T11	5 ACT+ RF	73.22	88.73	118.33	80.12
T12	10 ACT+RF	81.85	100.57	127.66	89.67
	Mean	75.60	88.39	109.72	84.50
		S.Em ±	**CD at5%**	**CV**	
	Varieties	0.700	1.970	**4.692**	
	Treatments	1.213	3.412		
	T×V	2.426	6.824		

Table 3: Effect of compost tea treatments on Dry weight of rice plants in field experiment conducted in *Kharif* of 2017 at GKVK

	Treatments	Dry weight (g)			
		ARB 6	**BR 2655**	**HR 12**	**KRH 4**
T1	Control	27.46	28.10	35.53	56.20
T2	Fungicide	25.66	30.18	37.66	52.59
T3	RF	34.92	25.89	22.80	49.32
T4	C W	28.66	48.84	32.74	50.91
T5	10 NCT	56.87	59.21	56.75	61.45
T6	5 NCT+RF+ST	54.07	50.12	54.68	78.66
T7	5 NCT+RF	53.30	56.78	52.24	71.78
T8	10 NCT+RF	43.23	59.80	53.29	78.12
T9	10 ACT	44.00	55.88	53.86	60.21
T10	5 ACT+RF+ST	39.52	59.31	50.32	68.19
T11	5 ACT+ RF	37.99	39.50	62.28	62.96
T12	10 ACT+RF	55.99	52.64	59.00	59.99
	Mean	44.05	47.19	47.59	62.53
		S.Em ±	CD at5%	CV	
	Varieties	0.467	1.312	5.562	
	Treatments	0.808	2.273		
	T×V	1.616	4.546		

Table 4: Effect of compost tea treatments on Chlorophyll Content of rice plants in field experiment conducted in *Kharif* of 2017 at GKVK

	Treatments	Chlorophyll Content (FW mg/ g)			
		ARB 6	BR 2655	HR 12	KRH 4
T1	Control	3.33	3.77	2.83	3.56
T2	Fungicide	3.57	3.80	2.60	2.90
T3	RF	3.97	3.47	2.80	2.87
T4	C W	4.07	3.83	2.47	2.90
T5	10 NCT	4.93	4.30	4.37	4.47
T6	5 NCT+RF+ST	4.50	4.43	4.27	4.53
T7	5 NCT+RF	4.40	3.97	4.40	4.47
T8	10 NCT+RF	4.50	4.13	4.50	4.27
T9	10 ACT	4.53	4.27	4.07	4.43
T10	5 ACT+RF+ST	4.50	4.20	4.13	4.07
T11	**5 ACT+ RF**	4.47	4.41	4.17	4.50
T12	10 ACT+RF	4.70	4.37	4.10	4.51
		S.Em ±	**CD at5%**	**CV**	
	Varieties	0.015	0.043	**2.163**	
	Treatments	0.026	0.074		
	T×V	0.053	0.148		

Table 5: Effect of compost tea treatments on peroxidase enzyme activity in rice leaves of field experiment conducted in *Kharif* 2017 at GKVK, Bangalore under aerobic cultivation.

	Treatments	**POX Activity** (µg/min/mg protein)			
		ARB 6	BR 2655	HR 12	KRH 4
T_1	Control	275.10	220.21	303.42	110.59
T_2	Fungicide	299.71	323.00	328.41	140.36
T_3	RF	297.15	273.00	320.59	139.74
T_4	C W	289.55	285.37	326.74	126.09
T_5	10 NCT	347.14	351.23	372.89	149.18
T6	5 NCT+RF+ST	339.66	343.35	414.55	165.69
T7	5 NCT+RF	348.62	397.83	438.62	192.06
T8	10 NCT+RF	321.86	320.44	353.03	145.51
T9	10 ACT	354.58	335.07	361.55	168.06
T10	5 ACT+RF+ST	353.31	345.38	439.72	182.68
T11	5 ACT+ RF	373.95	369.56	413.92	196.48
T12	10 ACT+RF	322.27	329.80	344.04	138.66
		S.Em ±	**CD at 5%**	**CV**	
	Varieties	1.425	4.007	**2.912**	
	Treatments	2.468	6.940		
	T×V	4.935	13.881		

Table 6: Effect of compost tea treatments on SOD enzyme activity in rice leaves of field experiment conducted in *Kharif* 2017 at GKVK, Bangalore under aerobic cultivation

	Treatments	SOD activity (µg protein/50% inhibition)			
		ARB 6	BR 2655	HR 12	KRH 4
T_1	Control	15.12	16.12	15.78	18.77
T_2	Fungicide	13.81	14.69	14.84	18.37
T_3	RF	14.06	13.51	15.17	17.23
T_4	C W	13.70	14.97	15.46	18.84
T_5	10 NCT	12.07	12.80	12.61	14.74
T6	5 NCT+RF+ST	11.60	13.72	11.93	14.65
T7	5 NCT+RF	10.23	10.74	10.80	12.19
T8	10 NCT+RF	12.50	11.78	13.91	13.98
T9	10 ACT	10.67	12.25	12.20	13.85
T10	5 ACT+RF+ST	10.15	11.17	12.14	12.86
T11	5 ACT+ RF	9.67	10.98	10.65	12.74
T12	10 ACT+RF	11.60	9.68	13.64	13.68
		S.Em ±	CD at 5%	CV	
	Varieties	0.120	0.338	5.413	
	Treatments	0.208	0.585		
	T×V	0.416	1.169		

Table 7: Effect of compost tea treatments on Number of Productive Tillers of rice plants in field experiment conducted in *Kharif* of 2017 at GKVK

	Treatments	Number of Productive Tillers			
		ARB 6	BR 2655	HR 12	KRH 4
T1	Control	17.05	9.22	14.00	15.99
T2	Fungicide	16.78	11.56	11.45	14.22
T3	RF	18.45	10.34	14.33	15.78
T4	C W	16.34	13.00	12.55	14.00
T5	10 NCT	21.67	16.78	18.00	17.11
T6	5 NCT+RF+ST	19.45	14.78	20.07	18.00
T7	5 NCT+RF	20.22	16.00	17.56	19.00
T8	10 NCT+RF	19.33	15.78	17.44	20.22
T9	10 ACT	18.44	16.33	18.07	18.99
T10	5 ACT+RF+ST	20.11	15.00	15.78	19.00
T11	5 ACT+ RF	18.24	15.62	16.74	19.34
T12	10 ACT+RF	20.91	16.78	16.85	19.33
		S.Em ±	CD at5%	CV	
	Varieties	0.245	0.689	8.675	
	Treatments	0.424	1.194		
	T×V	0.849	2.388		

Table 8: Effect of compost tea treatments on Grain Weight of rice plants in field experiment conducted in *Kharif* of 2017 at GKVK

	Treatments	**Grain Weight per plant (g)**			
		ARB 6	**BR 2655**	**HR 12**	**KRH 4**
T1	Control	18.40	15.29	15.43	25.44
T2	Fungicide	18.34	15.95	16.56	24.77
T3	RF	20.40	15.64	15.43	25.44
T4	C W	17.08	16.08	15.44	27.98
T5	**10 NCT**	32.34	18.45	21.12	33.44
T6	**5 NCT+RF+ST**	30.97	19.10	22.24	35.21
T7	5 NCT+RF	25.34	19.89	21.86	30.85
T8	10 NCT+RF	25.35	22.22	19.30	31.82
T9	10 ACT	23.21	19.26	23.88	34.17
T10	**5 ACT+RF+ST**	21.29	22.31	20.00	32.97
T11	**5 ACT+ RF**	21.87	22.31	24.21	32.22
T12	10 ACT+RF	21.15	20.62	22.23	33.40
	Mean	22.98	18.93	19.81	30.64
		S.Em ±	**CD at5%**	**CV**	
	Varieties	0.191	0.536	**4.995**	
	Treatments	0.330	0.929		
	T×V	0.660	1.858		

Fig.01a: Greenness difference between the control and CT treated plants

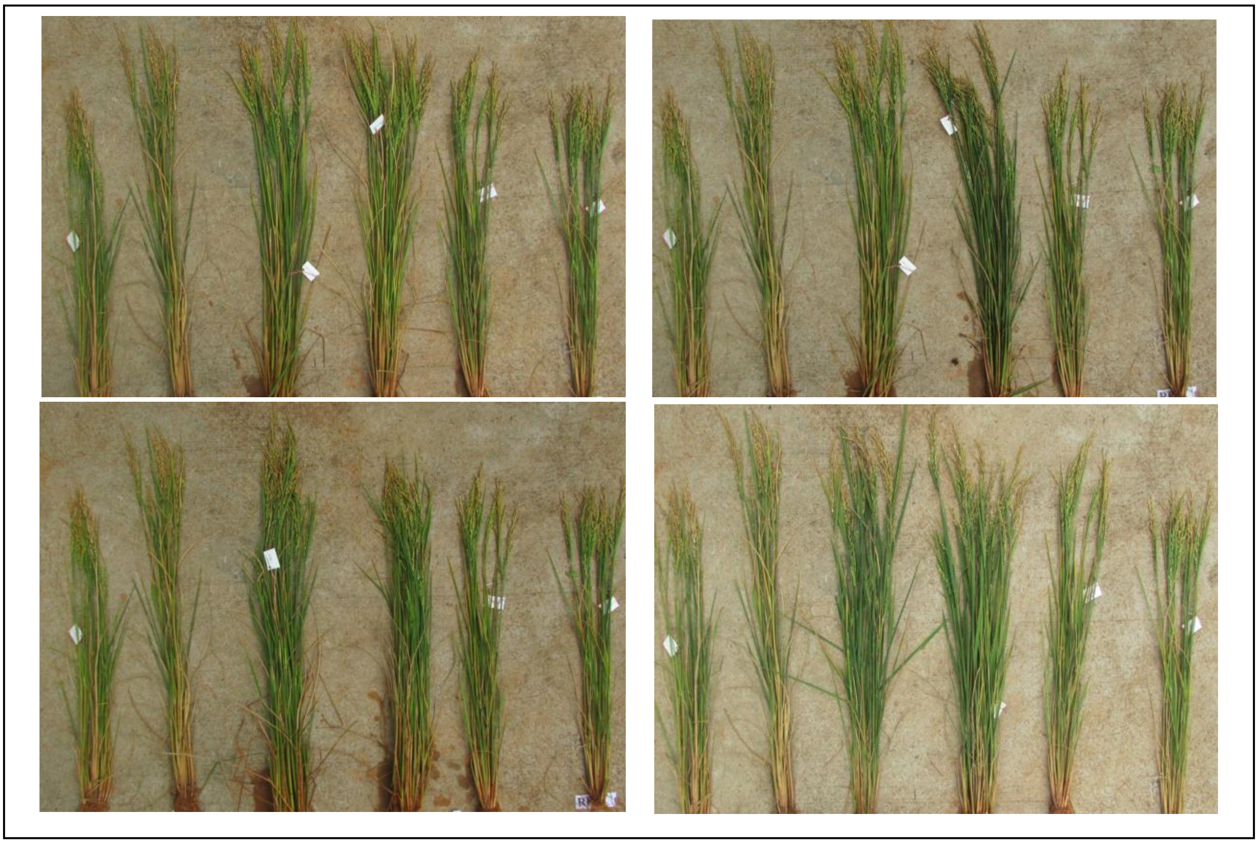

Fig.01b: Uprooted plants depicting differences in biomass and number of panicles in ARB 6 from rice field experiment conducted in Kharif 2017 at GKVK, Bangalore under aerobic condition

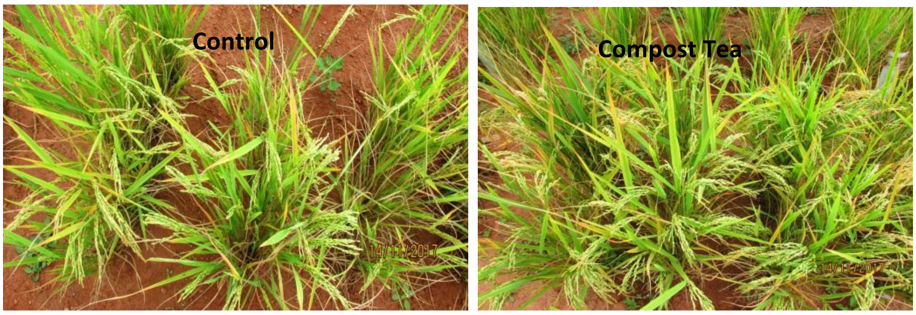

Fig.01c: Tillers Difference between the control and CT treated plants

Plate 02d: General field view of rice experimental field, under aerobic condition at GKVK, Bangalore.

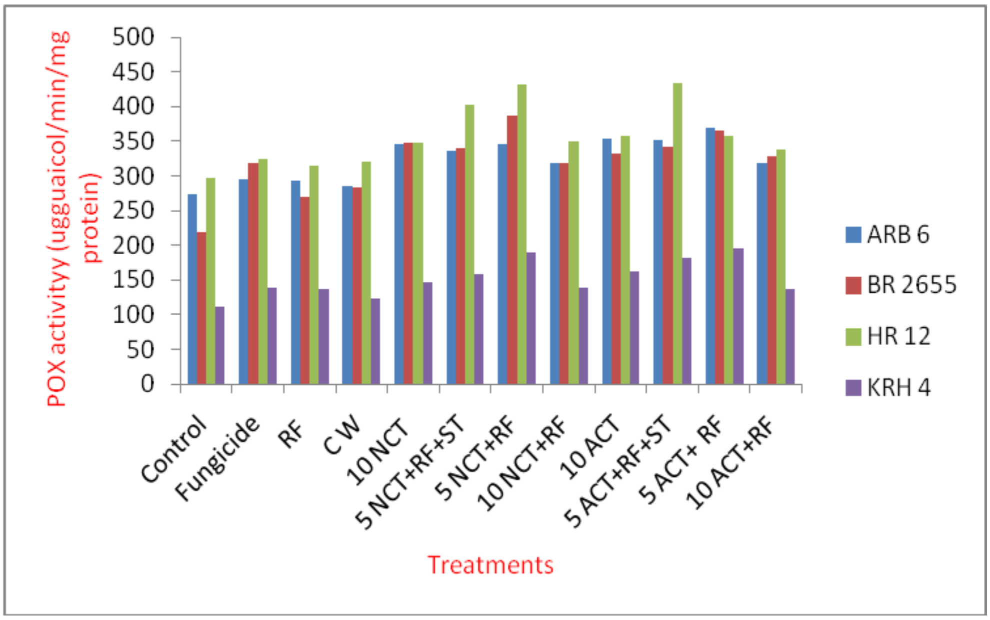

Fig.02a: POX activity in rice leaves (Spectrophotometer results)

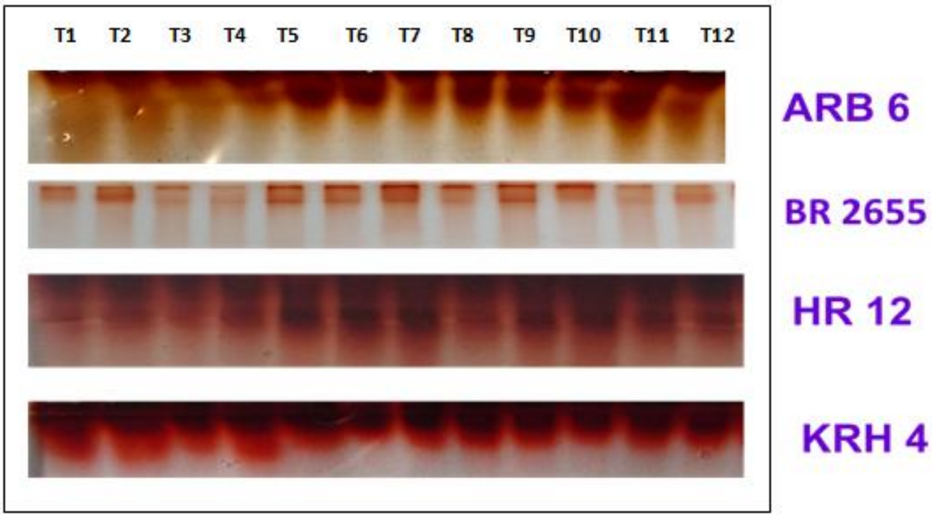

Fig.02b: In gel POX isoenzyme activity in proteins of leaf samples from Rice Field experiment conducted in Kharif 2017 at GKVK, Bangalore: T1: Control, T2: Fungicide, T3: RF ,T4: CW, T5: 10 NCT , T6: 5 NCT+RF+ST, T7: 5 NCT+RF, T 8: 10 NCT+RF, T9: 10 ACT, T10: 5 ACT+RF+ST, T11: 5 ACT+ RF, T12: 10 ACT+RF

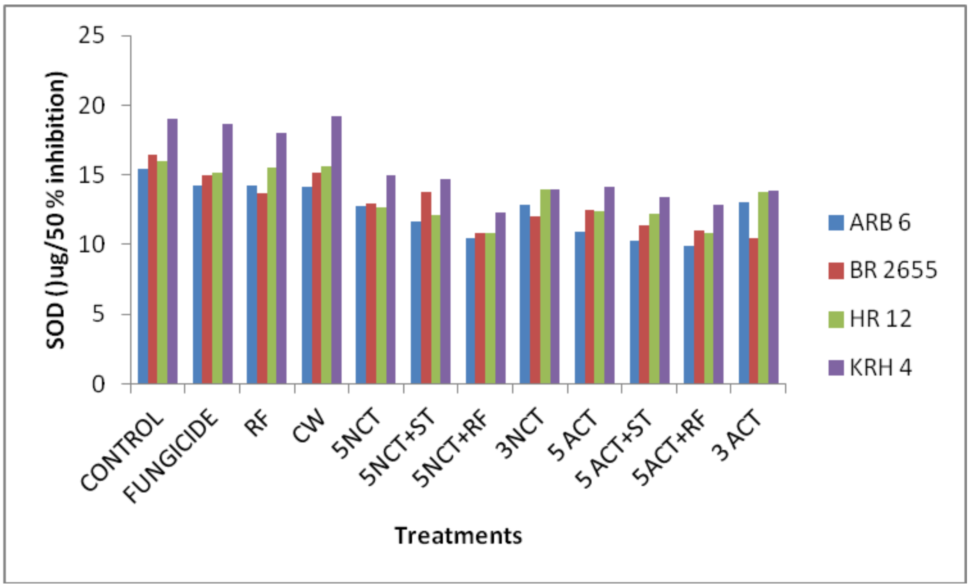

Fig.03a: SOD activity in rice leaves

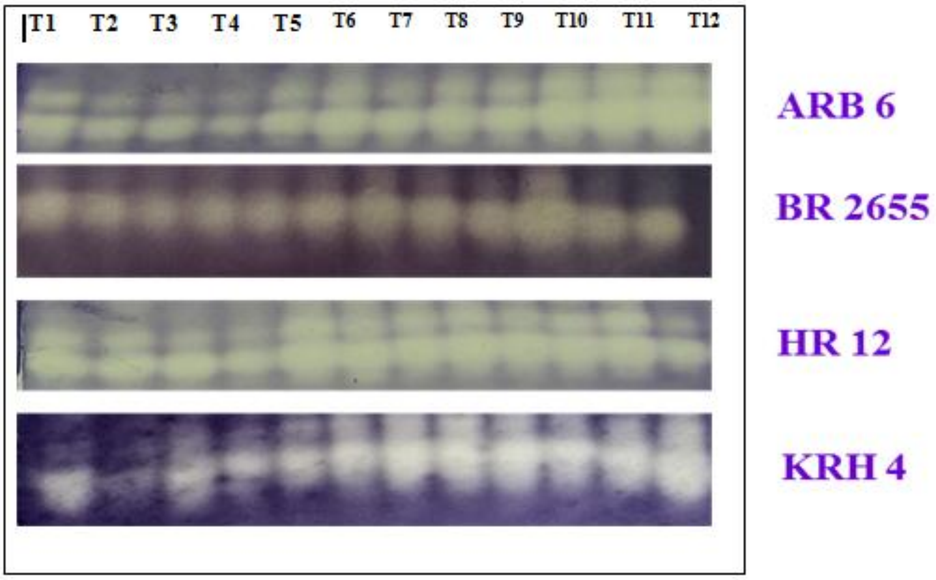

Fig.03b: In gel SOD isoenzyme activity in proteins of leaf samples from Rice Field experiment conducted in Kharif 2017 at GKVK, Bangalore: T1: Control, T2: Fungicide, T3: RF,T4: CW, T5: 10 NCT , T6: 5 NCT+RF+ST, T7: 5 NCT+RF, T 8: 10 NCT+RF, T9: 10 ACT, T10: 5 ACT+RF+ST, T11: 5 ACT+ RF, T12: 10 ACT+RF

CONCLUSION

This study shows that the ACT as well as NCT gave significant results in increasing the biomass and yield. There was no significant difference between 5 and 10 sprays of CT, so the farmers can opt to use 5 foliar sprays of NCT or ACT to get higher yield in their fields. Compost tea is a promising, eco-friendly, simple, economic, effective and safe technology that farmers can use as a biofertilizer and growth promoter to get benefits of increased yield.

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