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Effect of foliar application of PGRs on growth, yield and yield attributes of rice (*Oryza sativa* L.) under salt stress condition

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Abstract
The present investigation entitled "Effect of foliar application of PGRs on growth, yield and yield attributes of rice (*Oryza sativa* L.) under salt stress condition'' was conducted during the *kharif* season in 2016 at the MES Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad. The experiment was setup in randomized block design (Factorial) with three replications and seven treatments on rice varieties CSR-36 and CSR-43 under salt stress condition. The GA_3 (100, 150 and 200ppm) and salicylic acid (100, 150 and 200ppm) were applied as foliar application at 15 DAT. Growth, yield and yield attributes were taken after crop harvest. All PGRs showed superior value in all the stages of crop with respect to control. Growth parameters viz. plant height, number of tillers hill^{-1} and dry biomass plant^{-1}. Yield and yield attributing traits *viz*, length of panicles (cm), number of panicle hill^{-1}, number grains panicle^{-1}, grain yield plant^{-1}, grain yield q ha^{-1}, test weight (g) and harvest index (%), were found superior with foliar application of $GA_3$200ppm followed by SA 200ppm. Rice variety CSR-43 performed better than CSR-36 in all respects.

Keywords: PGRs, growth and yield

Introduction
Rice *(Oryza sativa L.)* is one of the most important stable food crop in the world. More than 90% of the world's rice is grown and consume Asia where 60% of the earth's people and about two-thirds of the world's poor live (Khush and Virk, 2000). In Asia more than 2 billion people are getting 60-70% of their energy requirementfrom rice, demand for rice is growing every year and it is estimated that in 2010 and 2025 AD the requirement was be 100 and would be 140 million tons, respectively. To sustain present food self-sufficiency and to meet future food requirement, India has to increase its rice productivity by 3% per annum (Thiyagarjan and selvaraju, 2001). Rice being climatically the most adopted cereal. It is grown over a large spatial domain and wide range of landscape type. A large number of unique paddy farming methods have also evolved, based on farming type (irrigated, rain fed, deep-water). Depending upon location Indian rice is grown in the *kharif* (summer, wet) or *Rabi* (winter, Dry) season both. Salt stress is one of the global problem rendering vast areas non suitable for cultivation. About 95 million ha earth surface is affected due to salt problem (Ghassemi, 1995). In Asia alone, 21.5 million ha area is affected of which 12.0 million ha are saline and 9.5 million ha are Alkaline. The salt affected soil are spread over 8.4 million ha (4% of the total cultivated area) in India and account for a loss of about us 300 million per dollars (singh *et al.,* 2003) Gibberellin (GA_3) control different developmental processes in plants (Pospíšilová, 2003). GA3 are responsible for expansion and cell division in shoot elongation, flowering and seed germination. All phyto-hormones exert their regulatory role in close relation with each other. Hormone signaling pathways form complex interacting network, which enables perceiving of numerous internal and external stimuli and generating respective plant responses. Additionally, exogenously appliedgrowth regulators can alter the content of endogenous phyto-hormones. The biosynthesis of GA_3 is regulated by both developmental and environmental (Yamaguchi & Kamiya, 2000). Salicylic acid is ortho-hydroxybenzoic acid and is a secondary metabolic acting as analogous of growth regulating substances. It helps in protection of nucleic acid and prevention of protein degradation. The salicylic acid is also known to induce many genes coding for parthenogenesis and proteins in response to biotic and

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abiotic stresses (Enyedi, *et al.,* 1992, Yalpani, *et al.;* (1994). Foliar application of salicylic acid increased the IAA content in board bean leaves (Xin, *et al.,* 2000). Foliar application of salicylic acid exerted a significant effect on plant growth metabolism when applied at physiological concentration, and thus acted as one of the plant growth regulating substance (Kalarani, *et al.,* 2002).

Materials and Methods

The Main Experiment Station (MES) of the Narendra Deva University of Agriculture and Technology, (Narendra Nagar) Kumarganj, Faizabad (U.P.)"Effect of foliar application of PGRs on growth, yield and yield attributes of rice (*Oryza sativa* L.) under salt stress condition'' In the present study, Variety CSR-36 and CSR-43 under salt stress condition was taken as experimental materials to find out the response of PGRs on growth and yield contributing traits of rice in RBD (Factorial) with three replications and seven treatments and varietes CSR-36 and CSR-43.Various foliar application of GA_3 (100, 150 and 200ppm) and salicylic acid (100, 150 and 200ppm)were applied as foliar application at 15 DAT. Growth parameters viz. plant height, number of tillers hill[-1] and dry biomass plant[-1]. Yield and yield attributing traits *viz,*

length of panicles (cm), number of panicle hill[-1], number grains panicle[-1], grain yield plant[-1], grain yield q ha^{-1}, test weight (g) and harvest index (%) were found superior with foliar application of GA_3 followed by Rice variety CSR-43 performed better than CSR-36 in all respects.

Results and Discussion
Plant height

The data with respect to plant height. Perusal of data revealed that the maximum plant height (74.40 cm) was recorded with sprayed of GA_3 200ppm, which found significantly superior over other treatments including control (36.52 cm). Almost similar pattern were followed at other stages of plant growth except at harvest stage, where non-significant variation was observed. As for as varieties were concerned the variety CSR-36(54.17 cm) showed significantly higher plant height as compare to CSR-43(50.95 cm).similar pattern was noted in succeeding growth stages of the plant.It may be because of genetically characters of the variety coupled with foliar sprayed of PGRs. Similar finding are agreement with Abd *et al.* (1997) Deka and DAS (1975), Shibario *et al.* (2001), Afshari *et al.* (2013)

Table 1: Effect of foliar application of PGRs on plant height (cm) of rice plant under salt stress condition.

Treatments	30 DAT			60 DAT			90 DAT			Harvest Stage		
	CSR36	CSR43	Mean	CSR36	CSR43	Mean	CSR36	CSR43	Mean	CSR36	CSR43	Mean
Control	37.50	35.59	36.52	67.01	63.68	65.34	95.90	92.31	94.10	95.93	93.41	94.67
GA3(100ppm)	59.39	54.83	57.11	77.95	76.20	77.07	104.16	99.34	101.7	104.19	100.05	102.1
GA3(150ppm)	68.32	64.59	66.45	86.61	80.70	83.65	112.16	103.25	107.1	112.21	103.67	107.9
GA3(200ppm)	76.56	72.23	74.40	98.53	86.55	92.54	115.02	108.89	111.9	115.12	109.13	112.1
SA(100ppm)	41.21	38.52	39.86	75.75	67.44	71.60	103.47	98.47	100.9	103.54	98.82	101.1
SA(150ppm)	45.83	43.40	44.61	84.59	76.57	80.76	105.52	100.56	103.0	105.78	100.86	103.3
SA(200ppm)	50.36	47.55	48.96	85.71	79.74	82.72	112.12	102.05	107.0	112.38	103.21	107.8
Mean	54.17	50.95	52.56	82.36	75.84	79.10	106.91	100.70	103.8	107.02	101.31	104.1
	V	T	VxT	V	T	VxT	V	T	VxT	V	T	VxT
SEm±	0.41	0.76	1.08	0.41	0.768	1.08	0.27	0.50	0.72	1.57	2.95	4.17
CD at 5 %	1.19	2.23	3.16	1.19	2.23	3.15	0.79	1.48	2.09	4.58	NS	NS

Number of tillers Plant[-1]

Observation with respect to number of tillers plant[-1] It is evident from the data that significant variations were observed due to main effect at different stages of plant growth. However, the maximum number of tillers hill[-1](7.61) was counted in variety CSR-43 as compare to CSR-36(7.31) at 30 DAT. Similar pattern was observed at other growth stages of

plant including harvest stage. The foliar application of GA_3 200ppm showed highest number of tillers plant[-1](8.16) over other treatments including control (6.33 tillers plant[-1]) at 30 DAT. Similar pattern were followed in succeeding stages of plant growth. These result are accordance with that of Elanhavi *et al.* (2009), Nitumoni *et al.* (2000) Kalavathi *et al.* (2000) and Yogesha *et al.* (2000)

Table 2: Effect of foliar application of PGRs on number of tillers hill[-1]of rice plant under salt stress condition

Treatments	30 DAT			60 DAT			90 DAT			Harvest Stage		
	CSR36	CSR43	Mean	CSR36	CSR43	Mean	CSR36	CSR43	Mean	CSR36	CSR43	Mean
Control	2.37	2.74	2.56	13.06	14.01	13.53	24.82	26.03	25.43	24.82	26.03	25.43
GA3(100ppm)	2.74	2.83	2.79	14.43	15.53	14.98	26.11	27.80	26.96	26.11	27.81	26.96
GA3(150ppm)	2.85	2.93	2.89	15.94	16.64	16.29	27.56	29.64	28.60	27.56	29.63	28.60
GA3(200ppm)	3.19	3.45	3.32	18.97	19.24	19.11	32.85	33.33	33.09	32.85	33.33	33.09
SA(100ppm)	2.71	2.79	2.75	14.56	15.84	15.20	25.96	26.66	26.31	25.96	26.66	26.31
SA(150ppm)	2.74	2.85	2.79	15.65	17.41	16.53	26.59	27.79	27.19	26.59	27.79	27.19
SA(200ppm)	3.12	3.22	3.17	18.57	.19.87	16.22	29.77	31.90	30.84	29.77	31.91	30.84
Mean	2.82	2.97	2.89	15.88	16.94	16.41	27.67	29.02	28.35	27.67	29.02	28.34
	V	T	VxT	V	T	VxT	V	T	VxT	V	T	VxT
SEm±	0.00	0.01	0.01	0.06	0.12	0.17	0.07	0.14	0.20	0.39	0.73	1.04
CD at 5%	0.01	0.03	0.04	0.19	0.36	0.51	0.22	0.42	0.60	1.14	NS	NS

Dry biomass hill[-1] (g)

Data with respect to plant dry biomass plant[-1]. It is apparent from the data that significantly higher plant dry biomass hill[-1] (2.97 g) was recorded in variety CSR-43 than CSR-36 (2.82), at 30 DAT. Similar pattern was followed in other stages of

plant growth except the harvest stage, which showed non-significant variation. As far as different treatments were concerned GA_3 200 ppm showed significantly higher dry biomass hill (3.32g) as compare to other treatments including control (2.56g) at 30 DAT. Similar pattern was noted in

succeeding growth stages. These result are accordance with that of Reddy *et al*. (2004) and Khan *et al.* (1998), Jeyakumar *et al.* (2008) reported that application of salicylic acid (125ppm increased the dry matter production (21.6 g/plant) in black gram.

Table 3: Effect of foliar application of PGRs on dry biomass hill [-1] of rice plant under salt stress condition.

Treatments	30 DAT			60 DAT			90 DAT			Harvest Stage		
	CSR36	CSR43	Mean	CSR36	CSR43	Mean	CSR36	CSR43	Mean	CSR36	CSR43	Mean
Control	5.66	7.00	6.33	7.89	8.78	8.33	9.66	9.77	9.72	9.81	10.01	9.91
GA₃(100ppm)	7.44	7.89	7.66	9.33	9.66	9.50	10.55	10.44	10.50	10.87	10.87	10.87
GA₃(150ppm)	7.66	7.55	7.61	9.88	10.55	10.22	11.00	11.22	11.11	11.97	11.73	11.47
GA₃(200ppm)	8.22	8.11	8.16	10.66	11.11	10.89	11.89	12.44	12.16	10.49	12.66	12.32
SA(100ppm)	7.33	7.44	7.38	9.00	10.11	9.55	10.33	10.55	10.44	10.49	10.68	10.59
SA(150ppm)	7.22	7.55	7.38	9.66	10.11	9.88	10.78	11.33	11.05	10.82	11.42	11.12
SA(200ppm)	7.66	7.77	7.72	10.22	10.66	10.44	11.44	11.66	11.55	11.87	11.87	11.87
Mean	7.31	7.61	7.46	9.52	10.14	9.83	10.81	11.06	10.93	11.01	11.32	11.16
	V	T	VxT	V	T	VxT	V	T	VxT	V	T	VxT
SEm±	0.08	0.15	0.21	0.08	0.15	0.21	0.09	0.18	0.25	0.10	0.19	0.27
CD at 5%	0.23	0.43	0.61	0.23	0.44	0.62	0.28	0.52	NS	0.30	0.56	NS

Length of panicles (cm)
Observation with respect to length of panicles (cm). It is evident from the data that significant variation was seen on length of panicles. The maximum length of panicles (20.45 cm) was noted in variety CSR-43 as compare to CSR-36 (19.82 cm). The foliar application of GA₃ 200ppm showed highest length of panicles (20.97 cm) over other treatments including control (19.21 cm). These findings are in close conformity to those of Veeramani, (2011)

Table 4: Effect of foliar application of PGRs on length of panicles (cm) in rice crop under salt stress condition

Treatments	Length of panicles(cm)		
	CSR36	CSR43	Mean
Control	18.64	19.77	19.21
GA₃(100ppm)	19.78	20.09	19.94
GA₃(150ppm)	20.20	20.29	20.25
GA₃(200ppm)	20.73	21.21	20.97
SA(100ppm)	19.55	20.27	19.91
SA(150ppm)	19.74	20.62	20.18
SA(200ppm)	20.09	20.88	20.49
Mean	19.82	20.45	20.13
	V	T	VxT
SEm±	0.08	0.16	0.23
CD at 5%	0.25	NS	0.67

Number of panicles hill[-1]
Data with requested to number of panicles hill[-1]. It is clear from the data that significantly higher number of panicle hill[-1] (9.91) was recorded in variety in CSR-43 than CSR-36 (9.00). Regarding different treatments were concerned GA₃ 200ppm showed significantly higher number of panicles hill[-1] (10.83) as compare to other treatments including control (7.85) These findings are in close conformity to those of Bora and Sharma (2006) [2, 5]

Table 5: Effect of foliar application of PGRs on no. of panicles hill[-1] in rice crop under salt stress condition.

Treatments	No. of panicles hill[-1]		
	CSR36	CSR43	Mean
Control	7.47	8.22	7.85
GA₃(100ppm)	8.92	9.15	9.04
GA₃(150ppm)	9.58	10.35	9.97
GA₃(200ppm)	10.24	11.42	10.83
SA(100ppm)	9.25	9.28	9.27
SA(150ppm)	8.26	10.25	9.26
SA(200ppm)	9.31	10.68	10.00
Mean	9.00	9.91	9.46
	V	T	VxT
SEm±	0.15	0.28	0.40
CD at 5%	0.45	0.84	1.19

Number of grains panicle[-1]
The data with respect to number of grain panicle[-1]. Perusal of data revealed that the maximum number of grains panicle[-1] (133.75) was recorded with GA₃ 200 ppm, which found significantly superior over other treatments including control (115.45).As far as varieties are concerned the variety CSR-43 (125.77) showed higher number of grains panicle[-1] as compare to CSR-36 (121.49).Similar pattern was noted in succeeding growth stages of the plant.

Table 6: Effect of foliar application of PGRs on number of grains panicle[-1] in rice crop under salt stress condition

Treatments	Grain yield plant[-1](g)		
	CSR36	CSR43	Mean
Control	7.32	8.11	7.72
GA₃(100ppm)	7.85	8.47	8.16
GA₃(150ppm)	8.25	9.38	8.82
GA₃(200ppm)	9.21	9.26	9.24
SA(100ppm)	8.12	8.58	8.35
SA(150ppm)	8.08	8.54	8.31
SA(200ppm)	8.43	9.12	8.78
Mean	8.18	8.78	8.48
	V	T	VxT
SEm±	0.12	0.23	0.32
CD at 5%	0.36	NS	NS

Grain yield plant[-1](g)
Observation with respect to grain yield plant[-1]. It is evident from the data that significant variation in grain yield plant[-1] (8.78) was observed in variety CSR-43 as compare to CSR-36(8.18).The foliar application of GA₃ 200ppm showed highest grain yield plant[-1] (9.24) over other treatments including control (7.72)

Table 7: Effect of foliar application of PGRs on grain yield plant[-1] (g) in rice under salt stress condition

Treatments	No. of Grains panicle[-1]		
	CSR36	CSR43	Mean
Control	112.3	118.6	115.45
GA₃(100ppm)	117.5	121.7	119.60
GA₃(150ppm)	123.6	126.5	125.05
GA₃(200ppm)	132.6	134.9	133.75
SA(100ppm)	118.5	123.5	121.00
SA(150ppm)	119.5	126.3	122.90
SA(200ppm)	126.4	128.9	127.65
Mean	121.49	125.77	123.63
	V	T	VxT
SEm±	1.74	3.26	4.61
CD at 5%	5.07	NS	NS

Grain yield (q ha⁻¹)

The data with respect to grain yield (q ha⁻¹). It is appertain from the data that significantly higher grain yield (38.08) was recorded in variety CSR-43 than CSR-36(36.96). As far as different treatments were concerned GA$_3$ 200ppm showed significantly higher grain yield (40.58) as compare to other treatment including control (34.77). These findings are in close conformity to those of Veeramani, (2011), and Ngatia *et al.*, (2004)

Table 8: Effect of foliar application of PGRs on rice yield (q ha⁻¹) under salt stress condition.

Treatments	Yield (q⁻¹ ha)		
	CSR36	CSR43	Mean
Control	34.21	35.32	34.77
GA$_3$(100ppm)	36.20	37.50	36.85
GA$_3$(150ppm)	37.30	38.22	37.76
GA$_3$(200ppm)	39.95	41.20	40.58
SA(100ppm)	36.05	36.61	36.33
SA(150ppm)	36.80	37.93	37.37
SA(200ppm)	38.20	39.80	39.00
Mean	36.96	38.08	37.52
	V	T	VxT
SEm±	0.57	1.08	1.52
CD at 5%	1.67	NS	NS

Test weight (g)

The data with respect to test weight. Perusal of data revealed that the maximum test weight (25.86 g) was recorded with GA$_3$ 200ppm which found significantly superior over rest of the treatments including control (22.89 g). As far as varieties were concerned the variety CSR-43 (25.26) showed significantly higher test weight compare to CSR-36 (24.27).

Table 9: Effect of foliar application of PGRs on test weight (g) of rice under salt stress condition

Treatments	Test Weight(g)		
	CSR36	CSR43	Mean
Control	22.38	23.38	22.89
GA$_3$(100ppm)	23.26	24.61	23.94
GA$_3$(150ppm)	24.87	25.48	25.18
GA$_3$(200ppm)	25.39	26.32	25.86
SA(100ppm)	24.63	25.29	24.96
SA(150ppm)	24.21	25.78	25.00
SA(200ppm)	25.12	25.95	25.54
Mean	24.27	25.26	24.76
	V	T	VxT
SEm±	0.27	0.51	0.73
CD at 5%	NS	NS	NS

Harvest index (%)

The observation with respect to harvest index. It is evident from the data that variation were maximum harvest index (39.72) was recorded in variety CSR-43 as compared to CSR-36 (38.41). Foliar application of GA$_3$ 200ppm showed higher harvest index (40.11) over other treatments including control (37.98).

Table 10: Effect of foliar application of PGRs on harvest index (%) of rice under salt stress condition.

Treatments	Harvest Index (%)		
	CSR36	CSR43	Mean
Control	37.42	38.54	37.98
GA$_3$(100ppm)	37.96	39.74	38.85
GA$_3$(150ppm)	38.25	39.87	39.06
GA$_3$(200ppm)	39.64	40.57	40.11
SA(100ppm)	38.29	39.29	38.79
SA(150ppm)	38.12	39.82	38.97
SA(200ppm)	39.18	40.23	39.71
Mean	38.41	39.72	39.07
SEm±			
CD at 5%			

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