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Foliar application of plant growth regulators on growth, yield and quality of hybrid rice

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Abstract

The field experiment was conducted on hybrid rice crop during growing season's 2015 and 2016 with foliar application treatment concentration viz; T₁: Control, T₂: GA₃ 20, T₃:GA₃ 40 ppm, T₄: IAA 25, T₅: IAA 50 ppm, T₆: NAA 10, T₇: NAA 20 ppm, T₈: Triacantanol 5, T₉:Triacantanol 10 ppm, T₁₀: Cycocel 3000 and T₁₁: Cycocel 4000 ppm with two foliar sprays (first spray at tillering and second at flowering stages for growth, yield and quality. The observation was recorded at different stages of crop. Higher doses of Cycocel reduced the plant height and Gibberellic acid GA₃ 50 ppm significantly increased the plant height, IAA 50 ppm increased carbohydrate content (mg g⁻¹ dry wt.), at all crop growth stages, chlorophyll fluorescence, protein content in straw, panicle dry weight plant⁻¹ (g), grain yield (kg/ha⁻¹) were recorded in comparison to control (T₁).

Keywords: Hybrid rice, GA₃, IAA, NAA, triacantanol (TRIA), Cycocel, plant height, carbohydrate, protein chlorophyll fluorescence, yield

Introduction

Rice is an important cereal crop in most of the country in the world. Globally rice is cultivated 154 million tonnes and average productivity of 3.9 tonnes per hectare. In India rice play key role it contributes also 46% of Indian cereal production and also staple food for two third of the population. India stands first in area and second in production. India has 44.13 million hectare and production 104.8 million tones (Agristatics at glance 2015). National Food Security Mission target of 3 million hectares, area under hybrid rice continue to range from 1.8 to 2.0 million hectares in the last few years. Rice is excellent source of carbohydrate. In future expansion of rice area may require large and costly investment, a substantial yield increase could be obtained with the wide adaptation of hybrid rice (Nguyen, 2010). The yield advantage of 15-20% over the best pure line varieties (6.5 t ha⁻¹ as against 5.4 t ha⁻¹) proved the key factor for wide adoption of the hybrid rice technology. PGRs regulate the amount, type and direction of plant growth with remarkable accomplishments of improved plant development and enhanced yield in several crops been documented (Shah *et al.* 2006; Emongor 2007) [19, 5].

Materials and methods

The field experiment were conducted during *Kharif* season 2015 and 2016, in Randomized Block Design with three replications on hybrid rice (PHB-71) at Student Instructional Farm at C.S. Azad University of Agriculture and Technology Kanpur, The experiment with foliar application of five growth regulators each in two concentration, total eleven treatment as GA₃ 20 and 40 ppm, IAA 25 and 50 ppm, NAA 10 and 20 ppm, Triacantanol 5 and 10 ppm, Cycocel 3000 and 4000 ppm and control which were replicated three times, two foliar spray was done at tillering and at flowering time. Total carbohydrate content in leaves was determined as per method describe by Yemm and Willis (1954) [23]. Nitrogen content in rice straw was estimated by using instrument, semi- auto nitrogen analyzer of model KEL PLUSH. This instrument work on the principal of kjeldahl's method of nitrogen analysis and protein content was evaluated by multiplying the nitrogen per cent by the coefficient 5.95. Observations on some growth and yield characters also recorded.

Result and Discussion

Plant growth hormones play essential role on increasing plant height of hybrid rice. The pooled analysis over two years data (Table 1) showed that the maximum plant height was

obtained due to application of GA₃ 20 and 40 ppm our finding supported by Roth (1987), Gavino *et al.*, (2008) [6], Jones (2009) [8] and IAA 25 and 50 ppm promoted the plant height in lower rate in comparison to GA₃ result of Sen and Bose

(1959) [18], Tomar *et al.*, (1971) [22], Panday *et al.*, (2001) [15, 16]. while CCC 3000 and CCC 4000 ppm decreased the plant height result of this study similar to those of Panday *et al.*, (2001) [15, 16], Mohagheh *et al.*, (2007) [11].

Table 1: Effect of various growth regulators on plant height (cm) of Hybrid Rice at different crop growth Stages

Treatments	Plant height (cm.)											
	30 DAT			60 DAT			90 DAT			Maturity		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T ₁ -Control	29.21	30.33	29.77	65.11	67.00	66.06	95.12	97.19	96.16	100.00	103.21	101.61
T ₂ -GA ₃ 20 ppm	35.16	37.00	36.08	71.76	73.36	72.56	102.40	105.63	104.02	110.22	113.69	111.96
T ₃ -GA ₃ 40 ppm	35.50	37.82	36.66	72.27	75.29	73.78	104.46	108.94	106.70	112.85	115.27	114.06
T ₄ - IAA 25 ppm	32.81	33.56	33.19	69.55	70.99	70.27	100.32	103.22	101.77	106.11	108.15	107.13
T ₅ - IAA 50 ppm	34.66	36.11	35.39	70.30	73.12	71.71	101.97	104.89	103.43	107.35	110.00	108.68
T ₆ - TRIA 5 ppm	31.11	32.49	31.80	69.87	71.66	70.77	100.29	102.48	101.39	103.68	106.57	105.13
T ₇ - TRIA 10 ppm	30.33	31.40	30.87	68.44	70.47	69.46	99.66	101.77	100.72	102.44	105.42	103.93
T ₈ - NAA 10 ppm	31.25	32.19	31.72	69.62	71.15	70.39	100.00	102.11	101.06	104.00	105.25	104.63
T ₉ -NAA 20 ppm	30.44	31.25	30.85	68.59	70.33	69.46	99.62	100.36	99.99	103.17	104.38	103.78
T ₁₀ - CCC 3000 ppm	28.11	29.20	28.66	61.15	65.85	63.50	94.16	94.25	94.21	95.69	96.27	95.98
T ₁₁ -CCC 4000 ppm	27.49	28.00	27.75	63.11	64.22	63.67	93.23	93.00	93.12	94.33	95.65	94.99
SE(d)	1.20	1.52	0.97	1.37	2.46	1.41	2.72	3.69	2.29	4.70	5.14	3.48
CD at 5%	2.05	3.17	1.96	2.86	5.12	2.83	5.67	7.70	4.63	9.81	10.74	7.04

Others treatments also enhanced the growth of rice crop in all stages. This change in plant height is mainly due to the stimulation due to stem elongation enhanced because of

application GA₃ and IAA contributed a lot in affecting plant height of rice. The higher plant height achieved with foliar application of GA₃ over control.

Table 2: Effect of various growth regulators on Carbohydrates content in leaves of Hybrid Rice at different growth Stages

Treatments	Carbohydrates content in leaves (mg g ⁻¹ dry wt.)											
	30 DAT			60 DAT			90 DAT			Maturity		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T ₁ -Control	80.00	81.00	80.50	110.00	111.95	110.98	126.00	127.00	126.50	140.28	140.58	140.43
T ₂ -GA ₃ 20 ppm	88.30	88.50	88.40	119.30	119.34	119.32	137.90	138.93	138.42	161.10	161.96	161.53
T ₃ -GA ₃ 40 ppm	89.20	91.00	90.10	120.10	120.53	120.32	138.70	139.10	138.90	164.26	164.96	164.61
T ₄ - IAA 25 ppm	91.60	92.70	92.15	125.40	126.10	125.75	142.60	142.80	142.70	167.11	168.02	167.57
T ₅ - IAA 50 ppm	92.10	93.40	92.75	131.26	132.59	131.93	145.36	146.00	145.68	170.28	171.00	170.64
T ₆ - TRIA 5 ppm	90.39	91.20	90.80	123.60	124.32	123.96	141.10	141.80	141.45	166.39	167.00	166.70
T ₇ - TRIA 10 ppm	89.10	90.10	89.60	121.29	122.66	121.98	139.30	139.60	139.45	161.80	161.85	161.83
T ₈ - NAA 10 ppm	87.20	87.90	87.55	119.20	120.20	119.70	136.80	137.00	136.90	160.00	161.00	160.50
T ₉ -NAA 20 ppm	86.30	87.20	86.75	117.38	118.10	117.74	134.10	134.90	134.50	158.28	158.89	158.59
T ₁₀ - CCC 3000 ppm	86.25	87.10	86.68	118.50	119.20	118.85	133.13	133.22	133.18	156.20	156.26	156.23
T ₁₁ -CCC 4000 ppm	85.70	86.60	86.15	117.89	118.10	118.00	132.20	133.00	132.60	155.00	155.20	155.10
SE(d)	1.76	2.19	1.37	3.45	3.81	2.51	2.78	3.12	2.08	2.39	2.62	1.78
CD at 5%	3.68	4.57	2.77	7.21	7.96	5.07	5.79	6.51	4.21	4.99	5.47	3.59

The effects of plant growth regulators on carbohydrate content in leaves of rice plant were significantly increased at different growth stages with foliar applied hormones. In pooled analysis over two years data (Table 2) showed that maximum carbohydrate content was recorded with the foliar spray of IAA 50 ppm followed by IAA 25 ppm compared to

control. Showed also similar result by Awan *et al.*, (1989) [1], Jones (2009) [8]. TRIA GA₃, CCC and NAA also increase the carbohydrate content in rice plant. Observation was favors of Krishanan and Kumari (2008) [10], Saynal *et al.*, (2001) [17], Kandil M.M. *et al.*, (2007) [9].

Table 3: Effect of various growth regulators on Chlorophyll fluorescence before flowering, at flowering time and Protein content in straw (%) of Hybrid Rice

Treatments	Chlorophyll fluorescence before flowering			Chlorophyll fluorescence at flowering time			Protein content in straw (%)		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T ₁ -Control	0.468	0.470	0.469	0.600	0.603	0.602	3.09	3.15	3.12
T ₂ -GA ₃ 20 ppm	0.597	0.599	0.598	0.710	0.712	0.711	3.45	3.51	3.48
T ₃ -GA ₃ 40 ppm	0.607	0.609	0.608	0.724	0.726	0.725	3.51	3.57	3.54
T ₄ - IAA 25 ppm	0.660	0.662	0.661	0.763	0.765	0.764	3.62	3.68	3.65
T ₅ - IAA 50 ppm	0.664	0.664	0.664	0.765	0.768	0.767	3.68	3.74	3.71
T ₆ - TRIA 5 ppm	0.624	0.626	0.625	0.759	0.761	0.760	3.57	3.62	3.60
T ₇ - TRIA 10 ppm	0.610	0.613	0.612	0.758	0.760	0.759	3.51	3.57	3.54
T ₈ - NAA 10 ppm	0.576	0.578	0.577	0.700	0.703	0.702	3.33	3.39	3.36
T ₉ -NAA 20 ppm	0.572	0.574	0.573	0.680	0.683	0.682	3.39	3.45	3.42
T ₁₀ -CCC 3000 ppm	0.557	0.560	0.559	0.650	0.655	0.653	3.33	3.39	3.36

T ₁₁ -CCC 4000 ppm	0.517	0.519	0.518	0.620	0.623	0.622	3.27	3.33	3.30
SE(d)	0.036	0.025	0.023	0.017	0.018	0.012	0.04	0.06	0.03
CD at 5%	0.080	0.049	0.046	0.035	0.037	0.024	0.08	0.13	0.07

Chlorophyll fluorescence significantly increased before flowering and at flowering time (Table 3) showed that the pooled analysis over two year data was highest increased by the foliar applied IAA followed by TRIA. GA₃ and NAA in different concentration also increased the chlorophyll fluorescence at different stages before flowering and at flowering similar supported by Aldesuquy H.S. (2001), Naeem *et al.*, (2004) [12, 14], Nazila *et al.*, (2005) [14], Chen *et al.*, (2003) [3], Borowski and Blamowski (2009) [2].

Protein content in straw an important quality traits, it is dependent on nitrogen content, maximum increase in rice straw protein in pooled analysis over two year data (Table 3) showed the foliar applied IAA 50 ppm followed by IAA 25 ppm. Others hormones in different concentration also enhance the rice straw protein in both the years 2015 and 2016. Similar supported by Sharma *et al.*, (2005) [20].

Table 4: Effect of various growth regulators on Panicle dry weight plant⁻¹(g) at flowering, Panicle dry weight plant⁻¹(g) at maturity and Grain yield kg/ha of Hybrid Rice.

Treatments	Panicle dry weight plant ⁻¹ (g) at flowering			Panicle dry weight plant ⁻¹ (g) at maturity			Grain yield kg/ha.		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T ₁ -Control	5.30	5.38	5.34	15.00	15.18	15.09	6600.0	6660.0	6630.0
T ₂ -GA ₃ 20 ppm	7.70	7.72	7.71	23.50	23.53	23.52	7326.0	7459.0	7392.5
T ₃ -GA ₃ 40 ppm	7.80	7.83	7.82	23.68	23.70	23.69	7459.0	7659.0	7559.0
T ₄ - IAA 25 ppm	8.00	8.07	8.04	24.50	24.51	24.51	8325.0	8458.0	8391.5
T ₅ - IAA 50 ppm	8.20	8.21	8.21	25.00	25.01	25.01	8391.0	8524.0	8457.5
T ₆ - TRIA 5 ppm	7.90	7.92	7.91	24.00	24.02	24.01	7659.0	7792.0	7725.5
T ₇ - TRIA 10 ppm	7.80	7.82	7.81	23.70	23.72	23.71	7525.0	7659.0	7592.0
T ₈ - NAA 10 ppm	7.50	7.53	7.52	22.80	22.81	22.81	7192.0	7326.0	7259.0
T ₉ -NAA 20 ppm	7.60	7.62	7.61	23.00	23.02	23.01	6993.0	7126.0	7059.5
T ₁₀ - CCC 3000 ppm	7.40	7.41	7.41	21.50	21.51	21.51	6859.0	7059.0	6959.0
T ₁₁ -CCC 4000 ppm	7.30	7.32	7.31	21.20	21.21	21.21	6793.0	6926.0	6859.5
SE(d)	0.48	0.49	0.33	1.01	1.05	0.71	369.5	427.7	275.9
CD at 5%	1.01	1.03	0.68	2.12	2.19	1.44	771.1	892.5	557.9

In pooled analysis over two year data (Table 4) showed that the panicle dry weight plant⁻¹ (g) at flowering and maturity was superior with the foliar applied IAA 50 ppm followed by IAA 25 ppm. Other treatments of different growth regulators in different concentration also give the better effect in the panicle dry weight plant⁻¹at flowering and maturity stages in both the years in 2015 and 2017. Ours finding also supported by Shim *et al.*, (1974) [21], Roy and Chaudhary (1981). The grain yield significantly increased by the application of plant growth regulators. In pooled analysis over two years data (Table 4) exhibited the maximum increased grain yield kg/ ha was recorded with the application of IAA 50 ppm followed by lower dose of IAA 25 ppm over control. TRIA, GA₃, and CCC in different concentrations also enhanced the grain yield kg/ ha in both the years 2015 and 2016, these data supported by Panday *et al.*, (2001) [15, 16], Choi *et al.*, (2010) [4], Hadole *et al.*, (2002) [7].

Conclusion

From the above data it may be concluded that the foliar sprayed plant growth regulators at vegetative and pre-flowering stage gave better response over control. IAA gave effective role in increasing carbohydrate content in leaves, chlorophyll fluorescence, protein content in straw, panicle dry weight plant⁻¹ (g), and grain yield kg/ha. In plant height GA₃ gave better enhanced of vegetative growth in rice crop during both years 2015 and 2016. So, the limited concentrations utilization of hormones stimulates the rapid cell division resulting faster physiological growth and produce better yield of hybrid rice crop.

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