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Effect of Phytohormones on growth and yield of rice

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ABSTRACT

The influence of combined application of Azospirillum, Penshibao (a biochemical product) and growth regulators (Triacontanol, GA_3 and Kinetin) on growth characters (plant height, number of tillers m^{-2} , LAI, Chlorophyll content and DMP) and yield parameters (number of panicles m^{-2}, total number of grains panicle^{-1}, number of filled grains panicle^{-1}, thousand grain weight, grain yield^{-ha} and straw yield^{-ha}) were studied. Among the several treatments, seed soaking with Azospirillum (1200 g ha^{-1}) and Penshibao 100ppm+foliar spray of Penshibao 100 ppm at 30 DAT+Miraculan (Triacontanol) 500 ppm+GA_3 5 ppm at 45 DAT significantly increased the growth characters and yield attributes. This was followed by seed soaking with Azospirilum (1200 g ha^{-1}) and Penshibao 100ppm+Miraculan (Triacontanol) 500 ppm+GA_3 5 ppm at 45 DAT. The increase in grain yield was up to 50.52% over control.

Key words: *rice, yield, Penshibao, triacontanol, Azospirillum, GA_3, kinetin*

The possibilities of further expansion of area under rice cultivation are limited in most of the rice growing countries including India. In this context, there is an imperative need to improve the production of food grains by employing improved/ innovative sustainable low cost agricultural technologies to meet the increasing demand for rice production. Poor yield of rice was attributed to poor translocation of carbohydrates from the source to the sink (panicle), which results in poor yield (Debata and Murty,1981). Growth hormones play an important role in the movement of accumulated carbohydrate to the sink. The present investigation was conducted to evaluate the effect of growth hormones and *Azospirillum* on growth and grain yield of rice under different treatment combinations.

MATERIALS AND METHODS

Field experiments were conducted during wet and dry seasons of 2001-03 at the Agronomy Farm, Faculty of Agriculture, Annamalai University, Tamilnadu. The experiments were laid out in randomized block design with three replications. Short duration rice variety ADT 36 was used in the study. Twenty two-day-old seedlings were planted in 5 x 4m plots with a spacing of 12.5 x 10cm. The variety was raised under optimum conditions of irrigation, nutrient supply and plant protection measures in the field. The soil was clay in texture having pH 6.7, EC 0.34 dsm, low in available N (246.50 kg/ ha) medium in available P (18.5 kg/ha) and high in available K (280.75 kg/ha). Penshibao is a bio-chemical product, which contains citric acid, zinc, boron, nitrogen (as urea), phosphorus, potassium, organic substances and dissolving agents. The treatments included T_1. Control, T_2. Soaking in *Azospirillum* (1200 g ha^{-1}), T_3. Seed soaking in *Azospirillum* (1200 g ha^{-1}) + Penshibao (100ppm), T_4. Seed soaking in *Azospirillum* (1200g ha^{-1}) + Penshibao (100ppm)+foliar spray of Penshibao 100 ppm at 30 DAT, T_5. Seed soaking in *Azospirillum* (1200 g ha^{-1})+Penshibao (100pm)+ foliar spray of Kinetin 5 ppm at 30 DAT, T_6. Seed soaking in *Azospirillum* (1200 g ha^{-1})+Penshibao (100ppm)+foliar spray of Vipul (Triacontanol) 500 ppm at 30 DAT , T_7. Seed soaking in *Azospirillum* (1200 g ha^{-1}) + Penshibao (100ppm)+foliar spray of Miraculan (Triacontanol) 500 ppm at 45 DAT. T_8. Seed soaking in *Azospirillum* (1200 g ha^{-1})+Penshibao (100ppm)+foliar spray of GA_3 5 ppm at 45 DAT, T_9. Seed soaking in *Azospirillum* (1200 g ha^{-1})+Penshibao (100ppm)+foliar spray Miraculan (Triacontanol) 500 ppm+GA_3 5 ppm at 45 DAT, T_{10}. Seed soaking in *Azospirillum* (1200 g ha^{-1})+Penshibao (100ppm)+foliar spray of Penshibao 100 ppm at 30 DAT+Miraculan (Triacontanol) 500

ppm+GA_3 5 ppm at 45 DAT, T_{11}. Seed soaking in *Azospirillum* (1200 g ha^{-1})+Penshibao (100ppm)+foliar spray of Penshibao 100 ppm+Vipul (Triacontanol) 500 ppm at 30 DAT, T_{12}. Seed soaking in *Azospirillum* (1200 g ha^{-1})+Penshibao (100ppm)+foliar spray of Miraculan (Triacontanol) 500 ppm at 45 DAT+5 ppm Kinetin at 30 DAT, T_{13}. Seed soaking in Penshibao (100ppm), T_{14}. Foliar spray of Penshibao 100ppm twice at 30 and 45 DAT, T_{15}. Seed soaking in Penshibao (100ppm)+foliar spray of Penshibao 100 ppm at 30 DAT.

Observations were taken on growth parameters and yield attributes on randomly five selected peg marked plants at periodical intervals. The mean values were used for statistical analysis suggested by Panse and Sukatame (1978). The concentration of growth regulators were prepared by serial dilution techniques.

RESULTS AND DISUSSION

The bio-chemical, biofertilizers and phytohormones significantly influenced the growth parameters, viz., plant height, number of tillers, leaf area index (LAI), chlorophyll content and dry matter production (Table 1). The treatment of seed soaking in *Azospirillum* (1200 g ha^{-1}) + Penshibao (100ppm)+foliar spray of Penshibao 100 ppm at 30 DAT+Miraculan (Triacontanol) 500 ppm+ GA_3 5 ppm at 45 DAT recorded significantly higher values for growth characters over the other practices. The production of vigorous seedlings at nursery stage due to the synergistic and cumulative effect of biofertilizer (*Azozpirillum*) and Penshibao could be the reason for better performance of the transplanted rice in terms of plant height, tiller number and dry matter production (Babu, 1998). This could be attributed to enhanced cell division and elongation by phytohormones (Ries and Wert, 1982). The foliar application of GA_3 at early growth stages resulted in the maximum plant height (Prabagaran and Ponnuswamy, 1997). The present findings of phytohormones (triacontanol) increasing the plant height is in line with the findings of Paraye *et al.*(1995). Increased leaf area index (LAI) could be attributed to the increased functional leaf area and delayed leaf senescence (Chen *et al.* 1982). With regard to chlorophyll content, applications of phytohormones increased the chlorophyll content mainly by delaying the leaf senescence (Debata and Murthy, 1981). The higher DMP might be due to accelerated cell division, photophosphorylation in chloroplast and increased storage of ATP in the crop enhances the plant growth (Chen *et al.,* 1982).

The nutrient and plant growth regulators significantly increased the yield parameters, viz., number of panicles m^{-2}, total number of grains $panicle^{-1}$, number of filled grains $panicle^{-1}$, thousand-grain weight. The treatment of seed soaking in *Azospirillum* (1200 g ha^{-1}) + Penshibao (100ppm)+foliar spray of Penshibao 100 ppm at 30 DAT+Miraculan (Triacontanol) 500 ppm+GA_3 5 ppm at 45 DAT recorded significantly higher values for yield and yield attributes over the other treatments. This was followed by the treatment of seed soaking in *Azospirillum* (1200 g ha^{-1}) +Penshibao (100ppm)+foliar spray Miraculan (Triacontanol) 500 ppm+GA_3 5 ppm at 45 DAT. The phytohormones spray may due to synchronous tillering, high nutrient availability and better assimilatory potentials cause the highest number of panicles m^{-2}. Similar trends of increased values were recorded in kharif and rabi seasons for different characters. Prabagaran and Ponnuswamy (1997) concluded that GA_3 spraying at panicle emergence stage would be ideal for enhancing panicle exsertion, seed set and yield during rice production. The maximum number of filled grains per panicle might be due to maintenance of higher succinic dehydrogenase activity, post flowering photosynthesis and assimilate partitioning to the sink (Biswas and Choudhuri, 1981). It also indicated that plants had sufficient leaf area. Thangaraj and Siva Subramanian (1992) concluded that foliar application of GA_3 at panicle initiation was found by delaying leaf senescence. Maugh (1981) reported that growth regulators might have helped in increasing the translocation and accumulation of carbohydrates and their availability for proper grain filling. Seed soaking with *Azospirillum* and Penshibao in conjunction with foliar spray of Penshibao, Miraculan and GA_3 registered grain yield of 5.75 and 5.42 t ha^{-1} in wet and dry seasons, respectively. This would be attributed to ideal nutrophysiological condition throughout the crop growth because of combination and synergistic effect of the above treatment combinations. The growth regulators may improve the fertilizer use efficiency leading to better seed filling through increased translocation and accumulation of carbohydrates from source to sink at the seed filling stage.

Table 1. Effect of Phytohormones, Bio-chemical and Bio-fertilizer on growth characters of rice.

Treatments	Plant height (cm)		Number of tillers m^{-2}		Leaf area index		Chlorophyll content (mg g^{-1})		Dry matter production (t ha^{-1})	
	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
T1	74.80	71.58	575.35	559.54	4.82	4.59	3.10	3.07	9.32	8.70
T2	77.15	73.98	598.52	587.07	4.97	4.72	3.17	3.14	9.75	10.03
T3	81.85	78.71	650.04	638.45	5.27	5.06	3.31	3.27	10.78	12.33
T4	86.54	83.32	698.34	685.05	5.60	5.32	3.49	3.41	11.70	14.60
T5	89.04	85.74	734.32	720.02	5.83	5.57	3.60	3.51	12.40	15.60
T6	88.94	85.71	719.85	704.35	5.75	5.48	3.56	3.47	12.17	15.63
T7	88.81	85.65	721.60	710.86	5.78	5.45	3.57	3.48	12.26	16.03
T8	88.84	85.66	729.24	717.75	5.81	5.51	3.59	3.50	12.34	15.46
T9	93.74	90.42	781.91	770.54	6.17	5.88	3.77	3.65	13.40	18.60
T10	96.08	92.73	808.10	791.82	6.32	6.01	3.84	3.72	13.85	19.93
T11	91.41	88.11	760.77	749.24	6.01	5.75	3.70	3.59	12.90	16.96
T12	91.36	88.07	756.56	741.32	5.98	5.70	3.67	3.57	12.84	16.96
T13	79.49	76.28	619.72	610.37	5.12	4.85	3.24	3.20	10.20	11.46
T14	84.20	81.01	674.24	660.75	5.45	5.19	3.40	3.35	9.22	14.90
T15	81.82	78.58	642.19	629.66	5.30	5.01	3.33	3.29	10.71	12.76
SED	1.16	1.14	10.3	9.12	0.07	0.06	0.026	0.024	0.20	0.19
CD(P=0.05)	2.31	2.28	20.2	18.3	0.12	0.12	0.052	0.048	0.40	0.38

Table 2. Effect of Phytohormones, Bio-chemical and Bio-fertilizer on yield and yield attributes of rice.

Treatments	Number of panicles m^{-2}		Total number of grains panicle $^{-1}$		Number of fiiled grains panicle $^{-1}$		Thousand grain weight (g) (t ha^{-1})		Grain Yield (t ha^{-1})		Straw yield	
	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
T1	265.71	249.52	72.40	66.70	54.75	53.59	20.72	20.63	3.82	3.40	5.72	5.30
T2	284.93	270.37	74.27	68.32	56.98	55.72	20.68	20.61	4.04	3.61	6.03	5.62
T3	335.62	320.98	78.55	72.20	61.38	58.92	20.70	20.74	4.44	4.01	6.51	6.15
T4	380.06	359.59	83.60	77.51	65.55	63.19	20.79	20.48	4.87	4.48	6.97	6.65
T5	418.42	400.72	87.05	80.60	67.98	65.20	20.58	20.48	5.13	4.77	7.31	7.00
T6	450.26	385.39	85.49	80.11	68.00	65.26	20.55	20.52	5.07	4.68	7.27	6.89
T7	409.67	391.87	86.27	80.32	68.05	65.28	20.48	20.40	5.09	4.71	7.20	6.95
T8	415.35	397.65	86.95	80.51	66.09	65.31	20.52	20.45	5.10	4.74	7.29	6.98
T9	467.99	448.60	90.92	84.80	72.30	69.42	20.75	20.69	5.56	5.20	7.79	7.45
T10	488.10	469.45	93.48	87.27	74.53	71.58	20.80	20.72	5.75	5.41	7.99	7.68
T11	445.78	426.08	89.10	82.67	70.00	67.29	20.68	20.63	5.39	5.00	7.56	7.20
T12	438.62	420.52	88.87	82.25	70.19	67.35	20.58	20.54	5.32	4.97	7.54	7.25
T13	305.12	290.12	76.65	70.40	59.20	57.54	20.51	20.07	4.23	3.81	6.26	5.90
T14	357.86	340.79	81.70	75.32	63.62	61.04	20.76	20.75	4.67	4.28	6.74	6.40
T15	326.32	315.77	79.67	72.91	61.45	59.94	20.55	20.43	4.48	4.08	6.49	6.10
SED	9.0	8.8	0.8	0.7	1.11	1.06	NS	NS	0.08	0.09	0.11	0.09
CD(P=0.05)	18.0	17.6	1.60	1.40	2.20	2.10	NS	NS	0.18	0.19	0.22	0.19

T_1. Control, T_2. Soaking in *Azospirillum* (1200 g ha^{-1}), T_3. T_2 + Penshibao (100ppm); T_4. T_3+foliar spray of Penshibao 100 ppm at 30 DAT; T_5. T_4+ foliar spray of Kinetin 5 ppm at 30 DAT; T_6. T4+foliar spray of Triacontanol 500 ppm at 30 DAT; T_7. T_3+foliar spray of Triacontanol 500 ppm at 45 DAT; T_8. T3 +foliar spray of GA_3 5 ppm at 45 DAT; T_9. T7+GA_3 5 ppm at 45 DAT ; T_{10}. T4+foliar spray of Penshibao 100 ppm at 30 DAT+Miraculan (Triacontanol) 500 ppm+GA_3 5 ppm at 45 DAT; T_{11}. T3+foliar spray of Penshibao 100 ppm+Triacontanol 500 ppm at 30 DAT; T_{12}. T7+5 ppm Kinetin at 30 DAT ; T_{13}. Seed soaking in Penshibao (100ppm); T_{14}. Foliar spray of Penshibao 100ppm twice at 30 and 45 DAT; T_{15}. Seed soaking in Penshibao (100ppm)+foliar spray of Penshibao 100 ppm at 30 DAT.

Marked differences in thousand grain weight were not observed between the treatments in both the seasons. The thousand grain weight is mainly governed by inherent genetic make up of the cultivar and the grain size is rigidly controlled by size of the hull (Yoshida 1981). Ray and Choudhuri (1981) reported that application of phytohormones increased the translocation of ^{32}P to grains and carbohydrate from source to sink resulting in increased grain yield.

Highest straw yield was recorded by application of phytohormones (GA^3 + miraculan) in combination with biofertilizers and Penshibao seed soaking in both the seasons. This might be attributed to higher biomass production at early stages of crop growth through increased utilization of nutrients, leading to higher leaf area index and consequent increase in photosynthetic rate (Ries and Wert, 1982).

It can be concluded that treatment of seed soaking in *Azospirillum* + Penshibao+foliar spray of Penshibao+Miraculan (triacontanol)+GA_3 holds promise as a viable and cost effective package of practices for profitable rice production.

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