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Effect of Bioregulators on Growth Analysis and Yield in Rice Fallow Maize

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ABSTRACT

A field experiment was conducted during *rabi* 2010-11at Agricultural College Farm ,Bapatla to study the effect of bioregulators on growth analysis and yield in rice fallow maize .Results revealed that significant differences were observed among the treatments for AGR, CGR,RGR,NAR, LAI ,SLW ,yield and yield components in rice fallow maize. Among the treatments foliar application of brassinosteroids 1ppm +thiourea 1000 ppm +kinetin 10 ppm at silking stage recorded higher values of AGR, CGR,RGR,NAR, LAI ,SLW , yield and yield components compared to other treatments in rice fallow maize.

Key words : Bioregulators, Growth analysis, Growth parameters, Maize, Rice fallow maize.

In India, Andhra Pradesh tops the list among the major producing states with the contribution of 17% to the total Indian maize production (Maize outlook report, 2007). It produces more vegetative growth under favorable climatic conditions thereby translocates the photoassimilates to the sink effectively for higher yields. Unavailability of water (drought) is the major constraint in rice fallow maize cultivation and is the major abiotic constraint determining maize yield. Understanding of various physiological ,biochemical mechanism underlying drought tolerance is needed for sustainable crop production under unfavorable environmental conditions.Bioregulators are considered as new generation agrochemicals after fertilizers ,pesticides and herbicides which enhance the crop yield. Foliar spray of plant growth regulators under water stress conditions may ameliorate the ill effects of water stress on growth and yield (Taiz and Zeiger ,2006) .Significant increase in the growth parameters like plant height ,leaf area ,leaf area index, drymatter ,AGR , CGR,RGR and SLW with the application of sitosterol at elongation and milky stages of bajra was reported by Mathur and Vyas (2007) . Foliar application of thiourea significantly increase the TDM,CGR ,RGR ,Chlorophyll and grain yield in maize (Sahu and Solanki ,1991) .There was a increase in leaf area and LAD of flag leaf and stem drymatter with increasing concentration of benzyl amino purine in wheat . Hence, the present investigation was planned to study the effects of bioregulators on growth analysis and yield in rice fallow maize.

MATERIAL AND METHODS

A field experiment was conducted at Agricultural College Farm Bapatla during *rabi* season of 2010. The experiment was laid out in sandy clay loam soil in randomized block design with 13 treatments and replicated thrice. Treatments consists of foliar application of brassinosteroids 1ppm at vegetative stage (T_1) , Brassinosteroids 1ppm silking stage (T_2) ,Thiourea 1000 ppm at vegetative stage (T_3) , Thiourea 1000 ppm at silking stage (T_4),Kinitin 10 ppm at vegetative stage (T_5) , Kinetin 10 ppm at silking stage (T_6) , Brassinosteroids 1ppm + thiourea 1000 ppm at vegetative stage(T_7) , Brassinosteroids 1ppm+ Thiourea 1000 ppm at silking stage (T_8) , Brassinosteroids 1ppm+ kinetin 10 ppm at vegetative stage (T_9) , Brassinosteroids 1ppm + Kinetin 10 ppm at silking stage(T_{10}) ,Brassinosteroids 1ppm +thiourea 1000 ppm +kinetin 10 ppm at vegetative stage(T_{11}), Brassinosteroids 1ppm +thiourea 1000 ppm +kinetin 10 ppm at silking stage(T_{12}) and water spray as control (T_{13}).The variety used in this study was 30-V-92. The plot size was 5 m x4 m .The crop was sown on 24th January 2011 with a spacing of 45cm x20cm after harvest of rice. Need based life irrigation was given. The crop was grown as per the recommended package of practices and timely plant protection measured was also adapted. Destructive analysis of plant samples was done at 35,55,75,95DAS and harvest. Five plants form each treatment were dugout along with roots and separated into leaf, stem, root, kernel and dried at

80^{0c} temperature in a hot air oven until constant weight was recorded separately. Leaf area was measured by LICOR 3000 leaf area meter .The growth parameters were computed from leaf area and drymtter .The data on yield and yield components were recorded at the time of harvest .The statistical analysis was done following Panse and Sukhatme(1978).

RESULTS AND DISCUSSION

The data on absolute growth rate (AGR) indicated that there was a decrease in AGR as growth stage advanced and high AGR was noticed at 35-55 DAS. At 15-35 DAS, there was no significant differences among treatments (Table1). Foliar application of bioregulators significantly increased the AGR at all stages of plant growth compared to control. Among all the treatments, Brassinosteroids 1ppm +Thiourea 1000 ppm + Kinetin 1ppm at vegetative stage increased the AGR by 51.3% at 35-55 DAS was superior . All the treatments are significant over control upto 55-75DAS and brassinosteroids recorded higher increase in the AGR over control which may be due to significant increase in the growth parameters like plant height ,leaf area ,leaf area index and drymatter with the application of sitosterol .The above results were in conformity with findings of Mathur and Vyas (2007).

Crop growth rate (CGR) is the product of leaf area index and net assimilation rate .The CGR was decreased as the age advanced (Table1). Foliar application of bioregulators significantly increased the CGR at all stages of plant growth .Among the bioregulators spray , brasinosteroids 10 ppm +thiourea 1000 ppm +Kinetin 1ppm at vegetative stage (T_{11}) recorded high CGR (9.96 g m^{-2} day^{-1}) which was on par with brassinosteroids 10ppm + thiourea 1000 ppm at vegetative stage (T_7-9.83 g m^{-2} day-1) and thiourea at vegetative stage (T_3-9.65 g m^{-2} day^{-1})followed by brassinosteroids 10 ppm at vegetative stage (T_1- 9.56 g m^{-2} day^{-1}).The increase in CGR in bioregulators treatments may be due to the stimulatory effects of bioregulators on plant metabolism and growth . The above results were in harmony with findings of Amin *et al.,* (2007) who reported that there was an increase in the physiological parameters like CGR , RGR ,NAR due to the increased drymatter accumulation and leaf area with the spray of benzyl adenine on white maize hybrid.

The data on Relative growth rate (RGR) indicated that there was decrease in RGR as growth stage advanced (Table1) and higher RGR was noticed during the period of 55-75 DAS. Foliar application of bioregulators significantly increases the RGR in all stages of plant growth over control. Among all the treatments ,brassinosteroids 10 ppm + Kinetin 1ppm + Thiourea 1000 ppm (T_{11}) recorded higher RGR(67.70 mg $g^{-1}d^{-1}$) followed by spray of brassinosteroids 1ppm at vegetative stage (T_1-66.58 mg $g^{-1}d^{-1}$) , brassinosteroids 10ppm + Thiourea 1000 ppm at vegetative stage(T_7 66.54 mg $g^{-1}d^{-1}$) which are on par . The increase of RGR under bioregulators might be associated with increased cell division and elongation by virtue of increased photosynthetic efficiency due to improved chlorophyll content and better developed assimilatory apparatus and increased drymater accumulation at growth stages (Sharma *et al.,* 2008).

During 35-55DAS and 95-harvest, differences among treatments were non significant regarding NAR .During 55-75 DAS all the treatments differ significantly on the influence of bioregulators on NAR of rice fallow maize where as during the period of 75-95 DAS ,some bioregulators treatments recorded significantly increased the NAR over control.(Table2). Among the bioregulators sprays, brassinosteroids 10 ppm + Kinetin 1ppm + Thiourea 1000 ppm at silking stage recorded higher followed by brasinosteriods 10ppm + Kinetin 1ppm + Thiourea 1000 ppm at vegetative stage compared to other treatments. A significant increase in the NAR was observed in the treatments and in the later stages of growth the effect of bioregulators was nullified and NAR values at 95DAS -harvest were on par with control. The above results are in harmony with the findings of Khan *et al.,* 2002, who reported hormone application improved the leaf area and drymatter production.

Leaf area index increased upto 75 DAS and decreased thereafter till maturity .Significant differences were observed among the treatments from 55 DAS to harvest and no significant differences were found between treatments in LAI at 35 DAS(Table2).Among the treatments , brassinosteroids 10 ppm + Kinetin 1ppm + Thiourea 1000 ppm at silking stage (5.66) followed by brassinosteroids 10 ppm + Kinetin 1ppm + Thiourea 1000 ppm at vegetative stage (5.61) compared to other treatments . The increased LAI might be due to the positive effect on cell division and cell elongation leading to enhanced leaf growth. The number of leaves per plant ,leaf area per plant and leaf area index were significantly increased due to application of bioregulators (Mathur and Vyas ,2007) .The above results were in harmony with findings of Amin *et al.,* (2007) in Maize.

Table1. Effect of bioregulators on AGR , CGR and RGR in rice fallow maize.

Treatments	Absolute growth rate (Cm d^{-1})				Crop growth rate (gm^{-2} d^{-1})				Relative growth rate(mgg^{-1d-1})			
	15-35 DAS	35-45 DAS	55-75 DAS	75-95 DAS	15-35 DAS	35-45 DAS	55-75 DAS	75-95 DAS	15-35 DAS	35-45 DAS	55-75 DAS	75-95 DAS
T1 .BR 1ppm at vegetative stage	4.07	4.41	3.18	0.16	9.56	2.83	1.31	1.20	43.90	66.58	24.46	16.67
T2. BR1ppm at silking stage	4.07	3.20	2.36	0.10	9.04	2.18	2.78	1.23	34.79	62.32	25.05	17.16
T3:Thiourea 1000 ppm at vegetative stage	4.06	4.32	3.04	0.28	9.65	2.68	1.29	1.18	43.59	65.16	23.36	13.40
T4: Thiourea 1000 ppm at silking stage	4.02	3.08	2.45	0.12	8.99	2.49	2.54	1.22	34.33	61.52	24.73	16.67
T5:Kinetin 10ppm at vegetative stage	4.11	3.83	3.33	0.16	9.41	2.62	1.82	1.14	42.27	65.07	22.97	13.63
T6: Kinetin 10ppm at silking stage	4.05	3.15	2.22	0.10	9.09	2.16	2.68	1.20	34.29	62.25	24.00	15.81
T7:BR 1ppm+ Thiourea 1000ppm at vegetative stage	4.04	4.67	3.12	0.16	9.83	2.47	1.40	1.13	43.27	66.54	23.68	16.20
T8: BR 1ppm+ Thiourea 1000ppm at silking stage	4.14	3.20	2.25	0.10	9.02	2.63	2.50	1.16	33.45	61.05	25.09	16.65
T9: BR 1ppm+ Kinetin 10ppm at vegetative stage	4.04	4.01	3.83	0.18	9.56	2.73	1.69	1.13	42.39	65.69	22.76	15.25
T10: BR 1ppm+ Kinetin 10ppm at silking stage	4.12	3.02	2.38	0.12	8.96	2.72	2.48	1.22	35.40	62.76	24.86	16.41
T11: BR 1ppm+ Thiourea 1000ppm +Kinetin 10ppm at vegetative stage	4.13	4.67	2.33	0.11	9.27	2.39	1.65	1.17	44.86	63.92	25.18	16.20
T12: BR 1ppm+ Thiourea1000ppm +Kinetin 10ppm at silking stage	4.12	3.16	3.45	0.15	9.96	2.44	2.48	1.24	34.75	67.70	25.72	17.94
T13:Control	4.09	3.09	2.35	0.10	9.12	1.75	1.53	0.96	33.23	57.96	18.09	12.68
CD at 5%	NS	0.22	0.20	0.05	0.32	0.36	0.31	0.27	1.42	2.00	1.07	0.91

BR: Brassinosteroids

Table 2. Effect of bioregulators on NAR , LAI and SLW in rice fallow maize.

Treatments	Net assimilation rate (mg cm^{-2} d^{-1})				Leaf area index				Specific leaf weight (mg cm^{-2})			
	15-35 DAS	35-45 DAS	55-75 DAS	75-95 DAS	35DAS	55DAS	75DAS	95DAS	35DAS	55DAS	75DAS	95DAS
T1 .BR 1ppm at vegetative stage	2.46	0.58	0.24	0.22	3.90	4.87	5.44	4.55	4.50	6.51	6.63	6.48
T2. BR1ppm at silking stage	2.51	0.48	0.52	0.24	3.61	4.51	5.30	4.74	4.49	5.81	6.59	6.54
T3:Thiourea 1000 ppm at vegetative stage	2.54	0.56	0.24	0.20	3.81	4.76	5.31	4.54	4.51	6.37	6.61	6.43
T4: Thiourea 1000 ppm at silking stage	2.51	0.56	0.49	0.22	3.59	4.55	5.22	4.67	4.48	5.91	6.58	6.47
T5:Kinetin 10ppm at vegetative stage	2.40	0.53	0.34	0.19	3.93	4.91	5.41	4.67	4.35	6.36	6.59	6.39
T6: Kinetin 10ppm at silking stage	2.53	0.48	0.51	0.22	3.59	4.52	5.23	4.87	4.51	5.84	6.58	6.45
T7:BR 1ppm+ Thiourea 1000ppm at vegetative stage	2.53	0.51	0.26	0.21	3.88	4.85	5.43	4.83	4.47	6.28	6.60	6.31
T8: BR 1ppm+ Thiourea 1000ppm at silking stage	2.51	0.59	0.47	0.24	3.59	4.49	5.36	4.87	4.43	5.97	6.59	6.38
T9: BR 1ppm+ Kinetin 10ppm at vegetative stage	2.44	0.56	0.31	0.21	3.91	4.89	5.51	4.76	4.45	6.41	6.58	6.42
T10: BR 1ppm+ Kinetin 10ppm at silking stage	2.49	0.60	0.47	0.23	3.60	4.50	5.35	4.87	4.33	5.83	6.56	6.46
T11: BR 1ppm+ Thiourea 1000ppm +Kinetin 10ppm at vegetative stage	2.55	0.62	0.52	0.24	3.95	4.94	5.61	4.80	4,52	6.53	6.64	6.54
T12: BR 1ppm+ Thiourea1000ppm +Kinetin 10ppm at silking stage	2.57	0.64	0.55	0.25	3.96	5.00	5.66	4.90	4.59	6.83	6.70	6.60
T13:Control	2.54	0.39	0.33	0.20	3.59	4.48	4.61	4.40	4.30	5.80	5.95	5.79
CD at 5%	NS	0.09	0.06	NS	NS	0.24	0.22	0.47	NS	0.21	0.22	0.21

BR: Brassinosteroids

Table 3. Effect of bioregulators on yield and yield components in rice fallow maize.

Treatments	No of cobs plant^{-1}	No rows cob^{-1}	No kernels row^{-1}	100 kernel weight (g)	Shelling percent	Harvest index (%)	Grain yield (t ha^{-1})
T1 .BR 1ppm at vegetative stage	1.23	13.05	33.37	28.12	79.35	43.25	8.75
T2. BR1ppm at silking stage	1.28	13.10	32.93	29.28	79.83	43.61	9.16
T3:Thiourea 1000 ppm at vegetative stage	1.26	13.12	32.86	29.37	78.73	43.66	9.10
T4: Thiourea 1000 ppm at silking stage	1.32	13.23	33.85	30.77	79.88	44.97	9.45
T5:Kinetin 10ppm at vegetative stage	1.16	12.84	32.78	27.28	76.69	42.37	8.24
T6: Kinetin 10ppm at silking stage	1.18	13.02	32.79	28.85	76.93	43.22	8.43
T7:BR 1ppm+ Thiourea 1000ppm at vegetative stage	1.27	13.34	33.49	29.47	80.55	44.32	9.27
T8: BR 1ppm+ Thiourea 1000ppm at silking stage	1.30	13.57	33.86	31.37	81.55	45.35	9.64
T9: BR 1ppm+ Kinetin 10ppm at vegetative stage	1.21	12.85	32.99	27.98	79.20	43.06	8.80
T10: BR 1ppm+ Kinetin 10ppm at silking stage	1.25	12.97	32.89	29.31	80.02	43.24	9.10
T11: BR 1ppm+ Thiourea 1000ppm+Kinetin 10ppm at vegetative stage	1.31	13.86	33.98	30.71	83.74	45.99	9.69
T12: BR 1ppm+ Thiourea 1000ppm+Kinetin 10ppm at silking stage	1.34	14.00	34.31	31.69	84.54	47.37	9.79
T13:Control	1.04	12.14	32.03	26.51	74.05	41.04	7.67
CD at 5%	0.10	0.45	0.76	0.66	2.10	1.19	0.41

BR: Brassinosteroids

An increase in specific Leaf weight (SLW) was observed from 35DAS to 75DAS and then decrease(Table 2) .There was significant differences observed among treatments for SLW at all stages of plant growth except 35 DAS . Foliar application of bioregulators significantly increase the SLW compared to control. Among the treatments, Foliar application of brassinosteroids 10 ppm + Kinetin 1ppm + Thiourea 1000 ppm at silking stage (6.70) followed by brassinosteroids 10 ppm + Kinetin 1ppm + Thiourea 1000 ppm at vegetative stage (6.64) where as lowest value was observed in control (5.95) .The spray of bioregulators were significantly superior to the control and these results were in accordance with the findings in maize by Amin *et al.,* (2007).

Yield in crop plants is the ultimate expression of many yield attributes and are depend on each other. There was significant differences between the treatments for number of cobs per plant ,number of rows per plant , number of kernel per cob,100kernel weight ,shelling percentage ,harvest index and grain yield (Table 3) . All the bioregulators significantly increased the yield and yield components compared to control. Among the treatments ,foliar application of brassinosteroids 10 ppm + Kinetin 1ppm + Thiourea 1000 ppm at silking stage recorded higher number of cobs (1.34 plant^{-1}) , number of rows(14.0 cob^{-1}) ,number of kernel (34.31 row^{-1}) ,100 kernel weight (31.69 g) ,shelling percentage (84.54%) ,harvest index (47.37%) and grain yield (9.79 t ha-1) followed by brassinosteriods 10 ppm + Kinetin 1 ppm + Thiourea 1000 ppm at vegetative stage compared to control. The higher grain yield under bioregulators might be due to increased nitrate reductase activity and photosynthetic rate which further reflected in biomass production grain number per ear and grain weight per ear (Sairam *et al.,* 1991). Application of kinetin on whole plant increased the longevity of the source organs and partitioning of assimilates thereby increasing grain yield (Biswas and Mandal ,1988) .Sivakumar *et al.,* (2006)reported that there was 19% increment in the yield due to spray of brassinosteroids which might

be due to enhance Co_2 fixation ,NR activity and effective partitioning of assimilates to the developing reproductive organs .From these study it can be conclude that foliar application of brassinosteroids 10ppm + Kinetin 1ppm + Thiourea 1000 ppm at silking stage increased the growth parameters and grain yield and yield components in rice fallow maize .

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