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Effect of Bioregulators on Growth 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 and yield in rice fallow maize .Results revealed that significant differences were observed among the treatments for plant height ,leaf area ,total drymatter ,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 plant height ,leaf area ,total drymatter, yield and yield components compared to other treatments in rice fallow maize.

Key words : Bioregulators, Growth, Kinetin, Rice fallow maize, Thiourea, Yield .

Maize is one of the most important cereals of the world and is an important staple food in many countries of the world. In India, Maize ranks third in cultivated area and production after wheat and rice and grown predominant as rainfed crop. 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). In Andhra Pradesh, the cultivation of maize has been extended into the rice fallow system with an area of 39000 ha and production of 180000 tons particularly in Guntur and Krishna districts. Corn yield is most sensitive to water stress during the stages of flowering and pollination followed by kernel filling. Post antheis moisture deficit reduces the kernel yield in maize by 50 -60% (Olaye *et al.,* 2009) .The planting of maize crop depends on the harvest of rice which is being delayed . Hence the crop is experiencing water deficit coupled with high temperature and it is becoming limiting factor in rice fallow maize production. To optimize the yield potential under such situation, in addition to the development or identification of cultivars, there is a need to work out technological and management strategies including the application of bioregulators (Jhannes,1984). Brassinosteroids are the steroidal plant hormone implicated in the promotion of plant growth and development .Brassinosteroids application also effective in ameliorating the adverse effects of abiotic stress (Shahbaz and Ashraf ,2007). Cytokinins play crucial role in regulation of coordination of plant metabolism ,growth and morphogenesis through modifying physiological and biochemical process of plants .(Gupta *et al.,* 2003).Foliar application of thiourea significantly increased the plant height ,leaf area ,drymatter and seed yield as compared to untreated control plants (Sahu and Solanki 1991).Much research work not done on effect of bioregulators on rice fallow maize . Keeping this in view it has been proposed to investigate the effect of bioregulators on growth and yield of 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) , Brasssinosteroids 1ppm silking stage (T_2) ,Thiourea 1000 ppm at vegetative stage (T_3) , Thiourea 1000 ppm at silking stage (T_4),Kinitin 10ppm at vegetative stage (T_5) , Kinetin 10 ppm at silking stage (T_6) , Brassinosteroids 1ppm + thiourea 1000 ppm at vegetative stage(T_7) , Brassinosteroids 1 ppm+ Thiourea 1000 ppm at silking stage (T_8) , Brasinosteroids 1ppm+ kinetin 10 ppm at vegetative stage (T_9) , Brasinosteroids 1 ppm + Kinetin 10 ppm at silking stage(T_{10}) ,Brasscinosteroids 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 45x20cm after harvest of rice. Need based life irrigation was given. The crop was grown following recommended package of practices and timely plant protection measured was also adapted.. Five plants form each treatment were dugout along with roots

Table 1. Effect of bioregulators on plant height and days to flowering in rice fallow maize.

Treatments	Plant height (Cm)				Days to 50% tassiling	Days to 50% silking
	35DAS	55DAS	75DAS	95DAS		
T1 .BR 1ppm at vegetative stage	103.40	191.50	255.20	256.5	46.7	54.0
T2. BR1ppm at Silking stage	103.10	167.10	214.20	214.70	47.3	55.2
T3:Thiourea 1000 ppm at vegetative stage	102.90	189.30	250.20	255.80	47.7	55.2
T4: Thiourea 1000 ppm at silking stage	102.60	164.20	213.30	213.60	47.9	55.9
T5:Kinetin 10ppm at vegetative stage	103.10	179.70	246.30	248.70	46.7	55.1
T6: Kinetin 10ppm at silking stage	103.10	166.00	210.30	213.30	47.0	56.2
T7:BR 1ppm+ Thiourea 1000ppm at vegetative stage	102.70	196.10	258.50	259.90	46.8	55.3
T8: BR 1ppm+ Thiourea 1000ppm at silking stage	104.00	168.10	213.20	214.30	48.2	55.8
T9: BR 1ppm+ Kinetin 10ppm at vegetative stage	102.70	183.00	259.60	263.30	46.5	55.4
T10: BR 1ppm+ Kinetin 10ppm at silking stage	104.30	164.70	212.30	213.50	48.3	56.7
T11: BR 1ppm+ Thiourea 1000ppm+Kinetin 10ppm at vegetative stage	103.30	196.60	213.80	213.90	46.5	54.7
T12: BR 1ppm+ Thiourea 1000ppm+Kinetin 10ppm at silking stage	104.00	167.20	265.50	267.30	47.7	55.7
T13:Control	103.40	165.00	212.10	213.10	48.3	56.7
CD at 5%	NS	2,2	2.3	3.0	NS	NS

BR:Brassinosteroids

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.For non destructive growth analysis 5 plants randomly selected in each plot and they were tagged ad observations like plant height, days to 50% silking ,days to 50% flowering was recorded . 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

Plant height had a continuous increase from the date of sowing to 95DAS.(Table1). There was a significant difference in plant height among treatments at all stages of growth except 35DAS because spray of bioregulators was done at 40DAS and 60DAS. Among all the treatments ,foliar spray of brassinosteroids 1ppm + thiourea 1000 ppm + Kinetin 10 ppm silking stage recorded higher plant height (267cm) at 95 DAS followed by brassinosteroids 1ppm + thiourea 1000 ppm at vegetative stage (263cm) where as least plant height was recorded in control (213cm) .The spray of brassinosteroids 1ppm + thiourea 1000 ppm + Kinetin 10ppm vegetative stage(T_{11}) exhibited 25% over the control. The increase in plant height in spray of bioregulators may be due to the stimulation of drymatter production through enhancement of cell division and cell elongation ,action of bioregulators on physiological process in plant such as ion uptake ,cell division ,cell elongation ,source –sink regulation , enzyme activities ,protein synthesis and photosynthetic activity .These results of significant growth promoting activity of bioregulaors are in conformity with Sakri and Amin (2009) in wheat and Wahed *et al.,* (2006) in maize .

There was no significant difference between the treatments for days to 50% tasseling and days to 50% silking .The spray of brasinosteroids 1ppm at vegetative stage (T_1-46 days and 54 days) and brasinosteroids 1 ppm+ thiourea 1000 ppm + Kinetin 10 ppm at vegetative stage(T_{11}- 46.5 and 54.7 days)took less number of days to 50% flowering and silking respectively compared to remaining treatments (Table1).Even though some of the treatments took less number of days to tassel and silking but there was no significant differences for this trait which suggests that this parameter is mainly a genetic factor . Moreover, the treatments were imposed at 40 DAS and 60DAS by that time the signal for ignition of flowering might have been set . On the other hand , Hold et al., 2010 observed that a significant decrease in length of period to antheis and silking when maize plant are treated by

Table 2. Effect of bioregulators on leaf area and total drymatter production in rice fallow maize

Treatments	Leaf area (Cm^2 $plant^{-1}$)				Total drymatter (g $plant^{-1}$)				
	35DAS	55DAS	75DAS	95DAS	35DAS	55DAS	75DAS	95DAS	Harvest
T1 .BR 1ppm at vegetative stage	3226	4385	4899	4094	8.4	180	231	255	268
T2. BR1ppm at Silking stage	3227	4056	4770	4266	8.3	171	210	260	280
T3:Thiourea 1000 ppm at vegetative stage	3225	4281	4783	4086	8.5	182	230	253	277
T4: Thiourea 1000 ppm at silking stage	3228	4035	4697	4198	8.2	170	215	260	280
T5:Kinetin 10ppm at vegetative stage	3229	4418	4872	4207	8.6	178	225	248	255
T6: Kinetin 10ppm at silking stage	3229	4032	4703	4381	8.4	172	210	249	259
T7:BR 1ppm+ Thiourea 1000ppm at vegetative stage	3229	4365	4885	4344	8.7	185	230	255	278
T8: BR 1ppm+ Thiourea 1000ppm at silking stage	3229	4041	4824	4386	8.0	170	217	262	283
T9: BR 1ppm+ Kinetin 10ppm at vegetative stage	3221	4401	4955	4286	8.1	179	228	259	278
T10: BR 1ppm+ Kinetin 10ppm at silking stage	3228	4053	4786	4384	8.1	168	217	262	280
T11: BR 1ppm+ Thiourea 1000ppm+Kinetin 10ppm at vegetative stage	3229	4442	4956	4315	8.2	187	218	260	275
T12: BR 1ppm+ Thiourea 1000ppm+Kinetin 10ppm at silking stage	3229	4054	5046	4413	8.1	174	230	263	281
T13:Control	3227	4034	4146	3959	8.3	172	203	231	249
CD at 5%	NS16.9	13.6	13.9	NS	NS	2.9	3.1	3.0	3.2

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

foliar spray with brasinosteroid during V6 /7 stage ,while kinetin and thiourea had no significant influence on the process of flowering .

The leaf area increased at increasing rate from 35DAS to 75 DAS and there after the leaf area decreased (Table 2).All the foliar spray treatments showed a significant difference over the control. Among the treatments ,foliar spray of brassinosteroids 1ppm+ thiourea 1000ppm + Kinetin 10ppm at silking stage (T_{12}) maintained highest leaf area (4413cm^2) followed by brassinosteroids 1ppm+ thiourea 1000 ppm (T_8- 4386 cm^2) , brasinosteroids 1ppm + Kinetin 10ppm(T_{10} – 4384 cm^2) compared to control (T_{13}- 3950 cm^2) . The decline of leaf area after 75-95 DAS might be due to activity of senescence in leaves. The higher leaf area in bioregulators treatments might be due to stimulation effect on physiological processes in plant such as ion uptake ,cell division ,cell elongation ,source –sink regulation , enzyme activities ,protein synthesis and photosynthetic activity .These results of significant growth promoting activity of bioregulaors are in conformity with Wahed *et al.,* (2006) in maize.

The total drymatter that can be produced and it further translocation to sink is the major factor that governs the economic performance of cultivar. The total drymatter increased continuously upto maturity in all the stages of plant growth (Table2) .There was significant differences among the treatments with regards total drymatter production. All the foliar spray bioregulators increased the total drymatter compared to control. Among the treatments , brassinosteroids 1ppm+ thiourea 1000 ppm (T_8- 283 g) which was on par with brassinosteroids 1ppm+ thiourea 1000 ppm + Kinetin 10 ppm at vegetative stage(T_{11}-281g) compared to control (T_1-249g) .The total drymatter maintained in vegetative parts and it s further translocation from source to sink is the major factor that govern the economic yield of the crop. Spray of brassinosteroids 1ppm+ thiourea 1000 ppm + Kinetin 10 ppm at vegetative stage recorded higher total drymatter production at all growth stages which is due to the cumulative effect of the bioregulators used and the effect of bioregulators on the increase of photosynthesis and maintenance of source sink relation among the parts of plant. Brassinosteroids significantly stimulated the root growth which results the secretion of organic acids and increased the availability of nutrients resulting in more chlorophyll synthesis .Thus high chlorophyll content resulted in high photosynthetic efficiency as reflected through the total drymatter .The above results were in support with the findings of Parihar, *et al.,* (1998).

Yield in crop plants is the ultimate expression of many yield attributes and 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 brassinosteroids 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 ad effective partitioning of assimilates to the developing reproductive organs .From these study it can be conclude that foliar application of brassinosteroids 10 ppm + Kinetin 1 ppm + Thiourea 1000 ppm at silking stage increased the growth parameters and grain yield and yield components in rice fallow maize .

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