



## Effect of Bioregulators on Physiological and Biochemical Parameters and Yield in Rice Fallow Maize

V Gowtham, K L Narasimha Rao, K Srinivasulu, G Rama Rao and Y Ashokarani

Department of Crop Physiology, Agricultural College, Bapatla 522 101 AP

### ABSTRACT

A field experiment was conducted during *rabi* 2010-11 at Agricultural College Farm, Bapatla to study the effect of bioregulators on physiological and biochemical parameters and yield in rice fallow maize. Results revealed that significant differences were observed among the treatments for RWC, SCMR, CSI, MII, total sugars, 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, CSI, Rice fallow maize, RWC, SCMR, Yield

Bioregulators have a wide spectrum of physiological roles in plants starting from growth regulation to gene expression. Apart from growth regulation, bioregulators have the ability to confer resistance to plants against various abiotic stresses (Rashed and Ahmad 1996). Application of growth regulators may modify morphological and physiological characteristics of plant and also induce better adaption of plant to environment which improved the growth and yield. Many reports are available on the foliar application of plant growth regulators which significantly improve the growth, drymatter production and yield under moisture stress deficit condition (Bajguz and Hayat, 2009). Brassinosteroids application on wheat results in increased relative water content, chlorophyll content, improved membrane stability and photosynthesis under stress and non stress conditions (Sairam, 1994). Foliar application of kinetin and IAA overcome the adverse affects of abiotic stress on physiological and biochemical properties like total drymatter production, grain yield, chlorophyll content and RWC in Maize. Less research work was done on these aspects in maize. Hence the present investigation was planned to study the effect of bioregulators on physiological and biochemical parameters 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 1 ppm silking stage ( $T_2$ ), Thiourea 1000 ppm at vegetative stage ( $T_3$ ), Thiourea 1000 ppm at silking stage ( $T_4$ ), Kinetin 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 x 4 m. The crop was sown on 24<sup>th</sup> January 2011 with a spacing of 45 cm x 20 cm 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. The data on RWC, SCMR, CSI, MII, total sugars were recorded 20 days time interval at 35, 55, 75, 95 DAS and the data on yield and yield components were recorded at the time of harvest. The statistical analysis was done following Panse and Sukhatme (1978).

Table 1. Effect of bioregulators on RWC,SCMR and CSI in rice fallow maize.

| Treatments   | Relative water content (%) |      |       |      |       |      | SCMR  |       |       |      |       |      | Chlorophyll stability index |      |       |  |       |  |       |  |
|--|----------------------------|------|-------|------|-------|------|-------|-------|-------|------|-------|------|-----------------------------|------|-------|--|-------|--|-------|--|
|  | 35DAS                      |      | 55DAS |      | 95DAS |      | 35DAS |       | 55DAS |      | 75DAS |      | 35DAS                       |      | 55DAS |  | 75DAS |  | 95DAS |  |
|  |                            |      |       |      |       |      |       |       |       |      |       |      |                             |      |       |  |       |  |       |  |
| T1: BR 1ppm at vegetative stage                                      | 82.7                       | 81.7 | 80.7  | 80.7 | 78.3  | 78.3 | 37.9  | 43.9  | 45.4  | 44.8 | 62.7  | 62.1 | 60.2                        | 50.1 |       |  |       |  |       |  |
| T2: BR1ppm at silking stage  | 83.0                       | 77.3 | 81.7  | 79.1 | 79.1  | 37.1 | 39.6  | 43.1  | 45.0  | 63.2 | 36.9  | 57.8 | 62.9                        |      |       |  |       |  |       |  |
| T3: Thiourea 1000 ppm at vegetative stage                            | 82.8                       | 78.3 | 79.2  | 78.3 | 78.3  | 37.7 | 40.6  | 43.4  | 43.5  | 62.1 | 49.6  | 49.1 | 46.1                        |      |       |  |       |  |       |  |
| T4: Thiourea 1000 ppm at silking stage                               | 83.0                       | 75.9 | 80.4  | 76.1 | 76.1  | 36.1 | 39.3  | 41.9  | 44.0  | 61.2 | 38.0  | 49.4 | 48.4                        |      |       |  |       |  |       |  |
| T5: Kinetin 10ppm at vegetative stage                                | 82.9                       | 80.0 | 80.4  | 78.5 | 78.5  | 37.9 | 42.2  | 45.4  | 44.7  | 62.4 | 65.3  | 65.3 | 59.8                        |      |       |  |       |  |       |  |
| T6: Kinetin 10ppm at silking stage                                   | 81.9                       | 76.4 | 80.0  | 78.3 | 78.3  | 35.5 | 38.1  | 43.3  | 46.0  | 62.8 | 38.5  | 60.8 | 64.2                        |      |       |  |       |  |       |  |
| T7: BR 1ppm+ Thiourea 1000ppm at vegetative stage                    | 81.8                       | 81.3 | 79.3  | 78.2 | 78.2  | 36.2 | 42.7  | 46.2  | 44.7  | 61.6 | 60.6  | 62.4 | 46.7                        |      |       |  |       |  |       |  |
| T8: BR 1ppm+ Thiourea 1000ppm at silking stage                       | 81.3                       | 77.6 | 81.1  | 77.5 | 77.5  | 37.7 | 39.8  | 43.50 | 46.0  | 62.8 | 36.8  | 59.4 | 60.6                        |      |       |  |       |  |       |  |
| T9: BR 1ppm+ Kinetin 10ppm at vegetative stage                       | 82.3                       | 82.0 | 80.8  | 80.1 | 80.1  | 37.1 | 43.8  | 47.1  | 46.3  | 62.9 | 64.7  | 65.4 | 62.4                        |      |       |  |       |  |       |  |
| T10: BR 1ppm+ Kinetin 10ppm at silking stage                         | 82.9                       | 79.7 | 82.0  | 80.9 | 80.9  | 36.2 | 39.2  | 46.5  | 46.0  | 62.9 | 37.6  | 64.9 | 63.0                        |      |       |  |       |  |       |  |
| T11: BR 1ppm+ Thiourea 1000 ppm + Kinetin 10 ppm at vegetative stage | 83.1                       | 81.8 | 79.3  | 76.1 | 76.1  | 38.1 | 43.5  | 45.1  | 47.7  | 61.7 | 64.6  | 63.5 | 62.2                        |      |       |  |       |  |       |  |
| T12: BR 1ppm+ Thiourea 1000 ppm + Kinetin 10ppm at silking stage     | 81.7                       | 76.3 | 80.7  | 78.9 | 78.9  | 37.2 | 40.1  | 47.1  | 48.2  | 62.4 | 68.6  | 63.5 | 64.6                        |      |       |  |       |  |       |  |
| T13: Control   | 83.0                       | 78.7 | 74.6  | 68.5 | 68.5  | 36.8 | 40.3  | 43.7  | 43.5  | 62.3 | 38.3  | 37.6 | 42.6                        |      |       |  |       |  |       |  |
| CD at 5%   | NS                         | 1.6  | 1.3   | 1.9  | 1.9   | NS   | 1.3   | 1.5   | 1.5   | NS   | 0.5   | 0.6  | 0.4                         |      |       |  |       |  |       |  |

BR:Brassinosteroids

## RESULTS AND DISCUSSION

The data on influence of bioregulators on Relative water content (RWC) in rice fallow maize at different stages were presented in Table 1. The RWC decreased from 35 DAS to 95 DAS in all the treatments. There was a significant difference among the treatments with regards to RWC except at 35 DAS. All the foliar application of bioregulators increased the RWC compared to control. Among the treatments foliar application of Brassinosteroids 1ppm + thiourea 1000 ppm + Kinetin 10 ppm at vegetative stage (T11- 4. % increase over control) maintained the high RWC in plants. Bioregulators spray maintained high RWC during grain filling stage in the treatment Brassinosteroids 1ppm+ Kinetin 10 ppm at silking stage (T10- 18.0 over control). This may be due to the spray of bioregulators. Sairam (1994) examined the effect of homobrassinolide on wheat which resulted in increased RWC, NR activity, chlorophyll content, improved membrane stability and photosynthesis under irrigated and moisture stress conditions.

The SPAD Chlorophyll meter reading (SCMR) increases upto 95DAS and decreases slightly at harvest (Table 1). There was significant difference among the treatments with regards to SCMR at all stages of plant growth except at 35DAS. Among the treatments, foliar application of Brassinosteroids 1ppm+thiourea 1000 ppm + kinetin 10 ppm at silking stage recorded higher SCMR of 48.2 followed by Brassinosteroids 1ppm+thiourea 1000 ppm + kinetin 10 ppm at vegetative stage (47.7) compared to control (43.3). The variation in the chlorophyll content due to foliar application of bioregulators may be attributed to decreased chlorophyll degradation and increased chlorophyll synthesis. Sivakumar *et al.*, (2011) reported that the foliar application triacontanol, salisalic acid, NAA and brassinosteroid and mepiquat chloride increased chlorophyll content in leaves of bajra.

The Chlorophyll stability index (CSI) values slowly decreased from 35 DAS to 95DAS in all the treatments. There was significant differences among the treatments for CSI. All the foliar application of bioregulators increases the CSI. Among the treatments foliar application of Brassinosteroids 1ppm+thiourea 1000 ppm + kinetin 10 ppm at silking stage recorded higher SCMR of 64.6 followed by Brassinosteroids 1ppm+thiourea 1000 ppm + kinetin 10 ppm at vegetative stage (62.2) compared to control (42.6). Rao *et al.*, (2002) reported that Brassinosteroids inhibit or counteract the stress,

resulting in higher membrane stability, chlorophyll stability under stress and production of stress related proteins which act against the stress.

Membrane stability is very important for normal plant metabolism. Membrane injury is often measured as leakage of solutes and ions from the cell. Membrane injury index (MI) was gradually increasing with the age of crop. There was a significant difference among the treatments due to the spray of bioregulators except at 35DAS which was on par with control. Among the treatments, kinetin spray at vegetative and silking stage recorded a less MI of 17.0 and 15.7% compared to other treatments. These results are in support with findings of Wang *et al.*, (2008) who reported that zeatin and GA<sub>3</sub> might play some role in maintaining cell membrane stability under water stress or the cell damages by increasing the levels of endogenous hormones of plant by induction of transgenic expression for the improvement of membrane stability in maize.

The total sugars increased from 35 DAS to 75DAS and later decline. There was significant differences among the treatments with regards to total sugars except at 35DAS. All bioregulators significantly increased the total sugars compared to control. Among the treatments foliar application of Brassinosteroids 1 ppm+thiourea 1000 ppm + kinetin 10 ppm at silking stage recorded higher values of sugars compared to other treatments. This may be due to cumulative effect of the bioregulators used resulting increased photosynthesis and maintenance of good source and sink relation. Gadallah and Sayed (2001) reported that stressed plants treated with kinetin had higher sugars than control. The increase in sugars may be an adoptive response which involves adjustment of osmotic potential that facilitates the maintenance of favorable water balance.

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 1 ppm + Thiourea 1000 ppm at silking stage recorded higher number of cobs (1.34 plant<sup>-1</sup>), number of rows (14.0 cob<sup>-1</sup>), number of kernel (

Table 2. Effect of bioregulators on membrane injury index and total sugars in rice fallow maize

| Treatments   | Membrane injury index(%) |       |       |       | Total sugars (mg g <sup>-1</sup> dry wt ) |       |       |       |
|--|--------------------------|-------|-------|-------|---|-------|-------|-------|
|  | 35DAS                    | 55DAS | 75DAS | 95DAS | 35DAS                                     | 55DAS | 75DAS | 95DAS |
| T1 .BR 1ppm at vegetative stage                                      | 32.6                     | 19.2  | 17.8  | 20.2  | 41.7                                      | 51.1  | 52.6  | 49.9  |
| T2. BR 1ppm at silking stage   | 32.6                     | 36.2  | 19.8  | 18.2  | 41.4                                      | 47.4  | 49.6  | 50.3  |
| T3:Thiourea 1000 ppm at vegetative stage                             | 32.4                     | 25.6  | 22.1  | 22.8  | 41.7                                      | 49.4  | 51.7  | 48.6  |
| T4: Thiourea 1000 ppm at silking stage                               | 32.4                     | 35.8  | 25.7  | 22.8  | 41.3                                      | 48.4  | 50.4  | 49.3  |
| T5:Kinetin 10ppm at vegetative stage                                 | 32.6                     | 18.0  | 16.1  | 17.0  | 40.5                                      | 51.3  | 53.0  | 48.0  |
| T6: Kinetin 10ppm at silking stage                                   | 32.6                     | 32.7  | 18.4  | 15.7  | 40.1                                      | 48.1  | 52.2  | 49.9  |
| T7:BR 1ppm+ Thiourea 1000ppm at vegetative stage                     | 31.2                     | 17.7  | 21.3  | 21.3  | 41.4                                      | 51.6  | 53.1  | 49.1  |
| T8: BR 1ppm+ Thiourea 1000ppm at silking stage                       | 32.6                     | 34.6  | 21.1  | 20.6  | 40.4                                      | 47.1  | 51.4  | 49.2  |
| T9: BR 1ppm+ Kinetin 10ppm at vegetative stage                       | 32.7                     | 17.4  | 15.7  | 17.6  | 41.7                                      | 50.4  | 51.6  | 48.4  |
| T10: BR 1ppm+ Kinetin 10ppm at silking stage                         | 32.3                     | 35.1  | 18.9  | 16.3  | 41.3                                      | 47.2  | 49.5  | 49.1  |
| T11: BR 1ppm+ Thiourea 1000 ppm + Kinetin 10 ppm at vegetative stage | 32.4                     | 18.5  | 19.2  | 17.7  | 41.2                                      | 54.2  | 52.1  | 49.4  |
| T12: BR 1ppm+ Thiourea1000 ppm + Kinetin 10ppm at silking stage      | 32.4                     | 33.8  | 17.5  | 17.7  | 41.6                                      | 50.5  | 53.5  | 50.4  |
| T13:Control  | 32.3                     | 33.6  | 33.6  | 33.3  | 41.4                                      | 45.5  | 48.1  | 44.3  |
| CD at 5%   | NS                       | 0.3   | 0.3   | 0.3   | NS  | 0.5   | 0.5   | 0.5   |

BR:Brassinosteroids

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

| Treatments   | No of cobs plant <sup>-1</sup> | No rows cob <sup>-1</sup> | No kernels row <sup>-1</sup> | 100 kernel weight (g) | Shelling percent | Harvest index(%) | Grain yield (t ha <sup>-1</sup> ) |
|--|--------------------------------|---------------------------|------------------------------|-----------------------|------------------|------------------|-----------------------------------|
| 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 1000 ppm + Kinetin 10 ppm at vegetative stage | 1.31                           | 13.86                     | 33.98                        | 30.71                 | 83.74            | 45.99            | 9.69                              |
| T12: BR 1ppm+ Thiourea1000 ppm + 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

34.31 row<sup>-1</sup>), 100 kernel weight (31.69 g), shelling percentage (84.54%), harvest index (47.37%) and grain yield (9.79 t ha<sup>-1</sup>) followed by brassinosteroids 10ppm + Kinetin 1ppm + 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 assimilated 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<sub>2</sub> fixation, NR activity and effective partitioning of assimilates to the developing reproductive organs. From these results it can be concluded that foliar application of Brassinosteroids 1 ppm+thiourea 1000 ppm + kinetin 10 ppm at silking stage increased the SCMR, CSI and total sugars and yield in rice fallow maize.

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(Received on 30.12.2011 and revised on 28.06.2012)