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Effect of ecofriendly chemicals on morphological and phenological characters of rice variety Uma under UV stress

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ABSTRACT

Rice is staple food for all over the world. Nowadays the production and productivity of rice crop affected by changing climate especially to high temperature and high concentration of ultraviolet-B radiation. This study evaluated the photo protective potential of ecofriendly chemicals like glycine betaine, ascorbic acid and combination fungicide *Nativo* (25 WG trifloxystrobin+ 50 WG tebuconazole) with two different concentration under two levels of solar radiation which is 100 and 80% solar radiation to get two levels of UV-B radiation. From diurnal observations of PAR and UV-B radiation revealed that, both are gradually increased from 8am to 12pm. Treatment effect of this experiment showed that under 100% and 80% solar radiation all the chemical treatments recorded higher height and tiller number than absolute control. Among chemical treatments *Nativo* 70ppm could enhance the grain filling period up to 6 days compared to absolute control under both condition which contributed maximum grain yield, it may be due to its ethylene inhibition capacity to decrease senescence and retain greenness in crops.

Key words: Ascorbic acid, Glycine betaine, UV-B, 25 WG trifloxystrobin, 50 WG tebuconazole.

INTRODUCTION

Global warming, stratospheric ozone depletion and acid rain are the different environmental stresses under climate change. Increase in greenhouse gases like CO_2, CFC, NO, N_2O, CH_4 are major gas pollutants for the destruction of ozone layer so it leads to elevation of surface UV-B radiation. Biological consequences of enhanced UV-B radiation on plants and animals are the great concern in current situation. In the tropical region the emission of UV-B radiation is high in full sunlight condition compared to temperate regions. Hence, rice as a tropical cereal crop receives higher level of ambient UV-B radiation (Tomen *et al*., 2003). Studies to protect rice crops from enhanced UV-B radiation through manipulative attempts are very few. Breeding and genetic improvements are the long term approach for UV-B tolerance. Exogenous application of stress alleviating ecofriendly chemicals is short and easy viable approach. Many reports describe the damage that occurs in cell membrane due to UV-B stress partially mitigated by plant growth regulators or organic solutes (Sharma and Dubey, 2005). Too high doses of UV-B radiation and Photosyntheticaly Active Radiation (PAR) interact with other stresses leading to photooxidative destruction of photosynthetic apparatus and inhibition of photosynthesis (Solhaag and Gauslaa, 2004). Under normal condition, glycine betaine induces UV-B stress tolerance by protecting photosystem II and Rubisco enzymes (Foolad and Ashraf, 2007). Application of glycine betaine may reduce the activity of ROS under elevated UV-B radiation. Mohammed *et al*. (2013) reported that under elevated UV-B radiation exogenous application of glycine betaine increased yield by 18% in rice. Ascorbic acid is an important antioxidant in the plants for scavenging the reactive oxygen species developed during stress and also it can induce the stress responsive genes to enhance plant protection against UV-B radiation. Hence it is a promising target to achieve higher yield under abiotic stresses like UV-B, drought, salinity and temperature (Khan *et al*., 2011).

Combination fungicide, 25 WG trifloxystrobin+ 50 WG tebuconazole (Trade name-Nativo 75 WG, Bayer Crop Science Ltd. Mumbai) is used for imparting tolerance to both biotic and abiotic stress. The active substance trifloxystrobin and tebuconazole present in *Nativo* can influence physiological alteration in plants causing longer retention of green leaf tissue, inhibition of ethylene biosynthesis, and increase in level of endogenous cytokinin and auxin, better nitrogen assimilation, increase in CO_2 assimilation, increase in water use efficiency and harvest index (Nagajothi, 2013). The efficacies of these chemicals are to be evaluated for providing recommendation in situations of UV-B stress in rice crop. With this background, this article contains the effect of glycine betaine, ascorbic acid and combination fungicide 25 WG trifloxystrobin+ 50 WG tebuconazole (*Nativo*) on morphological and phenological changes in rice under two levels of solar radiation (100 and 80% solar radiation) which give two levels of UV radiation.

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MATERIALS AND METHODS

Nine plants were selected randomly and tagged from each treatment to measure height of the plant at 45th day after transplanting (15 days after 1st treatment application). It was measured from the base of the plant to tip of longest leaf of the plant and expressed in centimeter. Number of tillers were counted by selecting two hills from each replication at maximum tillering stage and expressed as tiller per hill. The days when 50% panicle tip emerged from the flag leaf sheath in each pot is recorded as days to heading and this was counted from date of transplanting. Flowering stage was considered when stamens of spikelet came out and yellowish whitish structures was seen in spikelet of mother tillers. Number of days taken to complete 50**%** flowering in each treatment was counted from transplanting and the mean value expressed in days. Number of days taken for the crop to harvest was counted from transplanting date and mean value expressed as days to harvest. Grain filling period was derived by counting the number of days from 50% flowering to harvest for different treatments.

RESULTS AND DISCUSSION

Plant height: The mean data of plant height (Table.1) measured at the tillering stage showed significant variation between two growing conditions *viz.* 100% natural solar radiation and 80% solar radiation. Crop grown at 80% solar radiation recorded maximum height (71.06 cm) when compared to plants grown at 100% natural solar radiation (58.84 cm). The results indicated that ambient level of UV-B radiation significantly reduced the plant height of rice variety Uma. This may be due to the reduced internodal elongation under UV-B stress as reported earlier by Teramura and Sullivan (1994), which could be due to photo oxidative destruction of auxin followed by reduced cell wall extensibility as observed in sun flower (Ros and Tevini, 1995). Plants grown under reduced solar radiation (80% solar radiation) attained 17% higher plant height when compared to plants grown under 100% solar radiation, whereas there was 20% increase in tiller number recorded under ambient solar condition. UV-B exclusion studies conducted at Vellanikkara (Wagh, 2015) revealed that plant height and tiller number were higher under UV-B excluded condition in comparison with 100% and 80% solar radiation.

Significant variation in plant height was observed with different chemical treatments under two levels of UV-B conditions (Table 2). Under 100% solar radiation, among the chemical treatments, glycine betain-10ppm recorded maximum height (60.98 cm) which was on par with all other chemical treatment except both concentrations (50ppm and 70ppm) of *Nativo*, it was recorded lowest height (57.39 cm). Under 80% natural solar UV-B condition, both *Nativo*-70ppm and water spray recorded significantly higher plant height than other chemical treatments and absolute control. All other treatments were on par with absolute control. They could not enhance plant height under reduced UV-B condition.

In the present study among ameliorative chemical treatments, glycine betaine at both concentration (10ppm and 20ppm) and ascorbic acid 50 and 100ppm could enhance the plant height which was on par with water spray under 100% solar radiation. Glycine betaine as an osmolyte might have decreased the cell osmotic potential and thus maintained cell turgor pressure which is necessary for growth through cell elongation. Increment in plant height in glycine betaine treated plants may be due to the translocation of exogenously applied glycine betain to actively growing and expanding portions of crops which was previously explained by Makela *et al.* (1996). In another study it explain grain yield per plant had significant positive correlation with some morphological and phenological characters like biological yield , harvest index and days to flowering and panicle length(Das Sharma, 2015).

Tiller per hill : The mean values of number of tillers per hill at two growing conditions are given in Table 1. Tiller count was significantly more under ambient UV-B radiation (18 tillers hill^{-1}) when compared to 20% reduced ambient UV-B radiation (15 tillers hill^{-1}) irrespective of treatments. Data number of tiller hill under different chemical treatments are given in Table 3. Among treatments ascorbic acid-100ppm and water spray recorded significantly higher number of tiller count (19 tillers hill^{-1}) which was on par with all other treatments. The lowest tiller count was observed in treatment glycine betaine-10ppm (16 tillers hill^{-1}) and Nativo-70ppm (15 tillers hill^{-1}) under 100% solar radiation. Under 80% UV-B condition ascorbic acid 50ppm recorded significantly maximum tiller count (19.0 tillers hill^{-1}) when compared to all other treatments. The lowest tiller number was observed in absolute control (12.0 tillers hill^{-1}). Water spray and glycine betaine-10ppm were 2nd in producing maximum number of tillers (16 tillers hill^{-1}) which was on par with Nativo-70ppm (15 tillers hill^{-1}).

Table 1: Effect of two levels of UV-B radiation on plant height(cm), number of tillers per hill , days to heading, days to 50% flowering and days to harvest.

Condition	Plant height(cm)	No of tillers hill^{-1}	Days to heading	Days to 50% flowering	Days to harvest
100% solar radiation	58.84	18	73.96	76.64	115.92
80% solar radiation	71.06	15	66.83	71.13	111.63
CD(0.05)	**0.49**	**0.67**	**1.81**	**0.70**	**0.69**

Though glycine betaine enhanced the height, it could not enhance tiller number which was the lowest and on par with *Nativo* 50 and 70ppm. *Nativo* at both concentrations showed the lowest height under 100% solar radiation but it could cause 19% increase in height under 80% solar radiation. More over 70ppm *Nativo* caused maximum height under reduced UV level when compared to all treatments. This enhancement in height may be due to co-occurrence of other environmental factors like RH and temperature under reduced UV-B radiation in polyhouse. Crop received with treatment glycine betaine 10 ppm and *Nativo* 70ppm recorded lowest tiller number under 100% solar radiation indicating the ability of this chemical to cause moderate tillering which is an important trait associated with yield improvement. Plants received *Nativo* 70ppm exhibited moderate tillering ability under both condition. Ascorbic acid inhibits the adverse effect of NaCl for growth and development of plants. So ascorbic acid may be a promising treatment to ameliorate the deleterious effect of salt stress in crops (Nagda *etal.*, 2017).

Days to heading: Mean data on days to heading under two levels of UV-B radiation are presented in Table 1.Two levels of UV-B radiation revealed significant variation in days to heading. Plants grown under 100% ambient solar radiation took 74 days for heading whereas plants under 80% solar radiation headed within 67 days. Early heading was observed under reduced level of ambient UV-B radiation. The different treatments could not make significant effect on days to heading under 100% natural solar radiation whereas treatments expressed significant effect under reduced ambient UV-B condition (80% UV-B condition)(Table 4). Early heading was observed under absolute control (62 days) which was on par with other treatments. Among treatments more number of days to heading was recorded by Nativo-50ppm (72 days) followed by ascorbic acid-50ppm (68 days) and glycine betain-20ppm (67 days).

Days to 50% flowering: Data in Table 1 show that significant difference was observed in days to 50% flowering under two growing condition (100% and 80% solar radiation). Early completion of 50% flowering was observed under 80% solar radiation (71 days) and late completion of 50% flowering occurred under100% solar radiation (76 days). All chemical treatments could contribute a significant effect on days to 50% flowering under both ambient and reduced solar radiation (Table 5). Under 100% solar radiation glycine betaine-10ppm, Nativo-70ppm and ascorbic acid-10ppm completed 50% flowering at 75, 73 and 75 days respectively whereas all other treatments took 78 days to complete 50% flowering. The absolute control also took more days (78) to complete 50% flowering. Under 80% solar radiation all the treatment effect was on par except Nativo-50ppm which recorded significantly more number of days (74 days) to complete 50% flowering. In the present

Table 2: Effect of treatments on plant height (cm) under two levels of UV-B radiation.

Treatments	100% solar radiation	80% solar radiation
Glycine betaine – 10ppm	60.98	71.06
Glycine betaine – 20 ppm	60.72	71.12
Ascorbic acid - 50 ppm	59.78	70.91
Ascorbic acid - 100 ppm	60.11	70.65
Nativo 75 WG - 50 ppm	57.39	70.71
Nativo 75 WG - 70 ppm	57.39	71.61
Water spray	59.17	71.58
Absolute control	55.22	70.83
CD(0.05)	**1.93**	**0.43**

Table 3: Effect of treatments on number of tillers hill^{-1} under two levels of UV-B radiation.

Treatments	100% solar radiation	80% solar radiation
Glycine betaine – 10ppm	16.0	16.0
Glycine betaine – 20 ppm	17.0	14.0
Ascorbic acid - 50 ppm	18.0	19.0
Ascorbic acid - 100 ppm	19.0	14.0
Nativo 75 WG - 50 ppm	18.0	14.0
Nativo 75 WG - 70 ppm	15.0	15.0
Water spray	19.0	16.0
Absolute control	18.0	12.0
CD(0.05)	**1.40**	**2.43**

Table 4: Effect of treatments on days to heading under two levels of UV-B radiation.

Treatments	100% solar radiation	80% solar radiation
Glycine betaine – 10ppm	72.00	67.00
Glycine betaine – 20 ppm	75.00	68.00
Ascorbic acid - 50 ppm	74.00	68.00
Ascorbic acid - 100 ppm	71.00	66.00
Nativo 75 WG - 50 ppm	76.00	72.00
Nativo 75 WG - 70 ppm	70.00	64.00
Water spray	76.00	66.00
Absolute control	76.00	62.00
CD(0.05)	**NS**	**5.02**

Table 5: Effect of treatments on days to 50% flowering under two levels of UV-B radiation.

Treatments	100% solar radiation	80% solar radiation
Glycine betaine – 10ppm	75.00	71.00
Glycine betaine – 20 ppm	78.00	71.00
Ascorbic acid - 50 ppm	78.00	71.00
Ascorbic acid - 100 ppm	75.00	70.00
Nativo 75 WG - 50 ppm	78.00	74.00
Nativo 75 WG - 70 ppm	73.00	70.00
Water spray	78.00	71.00
Absolute control	78.00	72.00
CD(0.05)	**2.67**	**2.74**

study under ambient condition UV-B altered the different phenophases and prolonged time to achieve days to heading, days to 50% flowering and days to harvest. Plants attained all the phenophases 4-5days earlier under UV-B reduced condition (80% solar radiation) (Fig 1). The earliness to achieve all the phenophases under reduced solar condition may be due to the high chlorophyll content which in turn induce high photosynthetic rate at tillering stage and leads to early ripeness to flowering. Similar studies to evaluate crop response under abiotic stresses revealed that plants grown under stress condition took more days for flowering and maturity when compared to plants grown under controlled conditions (Shikuku *et al*., 2010).

Table 6: Effect of treatments on days to harvest under two levels of UV-B radiation.

Treatments	100% solar radiation	80% solar radiation
Glycine betaine – 10ppm	115.00	111.00
Glycine betaine – 20 ppm	116.00	111.00
Ascorbic acid - 50 ppm	117.00	112.00
Ascorbic acid - 100 ppm	116.00	112.00
Nativo 75 WG - 50 ppm	116.00	113.00
Nativo 75 WG - 70 ppm	116.00	113.00
Water spray	116.00	112.00
Absolute control	115.00	111.00
CD(0.05)	**NS**	**NS**

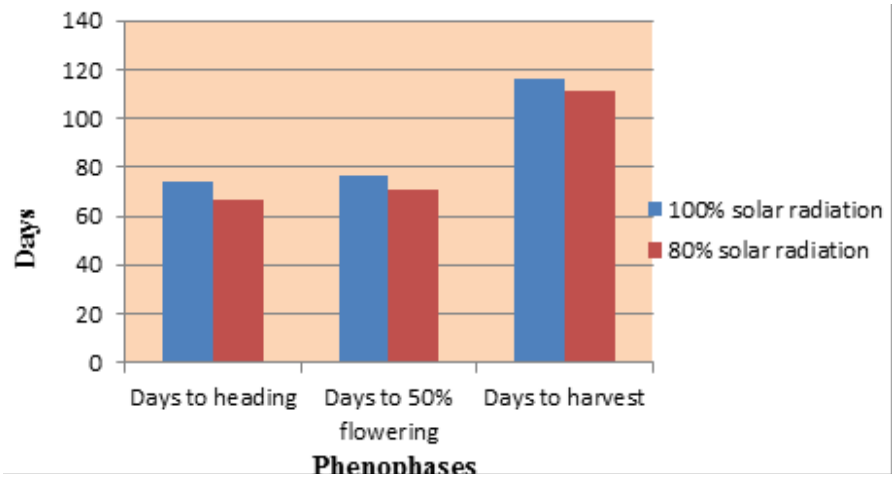

Fig 1: Variation in phenophases of rice under two levels of UV-B radiation.

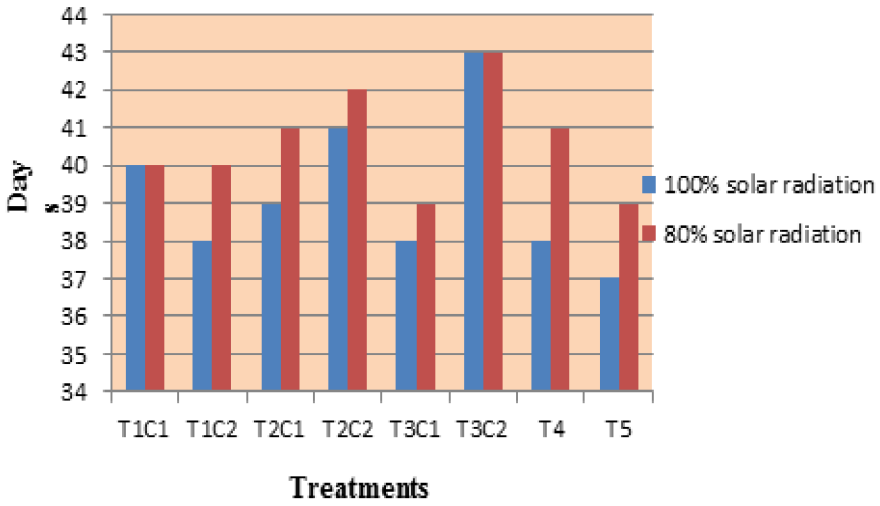

Fig 2: Variation in grain filling period of rice among different chemical treatments under two levels of UV-B radiation.

T_1C_1 - Glycine betaine - 10ppm
T_1C_2- Glycine betaine - 20 ppm
T_2C_1 - Ascorbic acid - 50 ppm
T_2C_2 - Ascorbic acid - 100 ppm
T_3C_1 - Nativo 75 WG - 50 ppm
T_3C_2 - Nativo 75 WG - 70 ppm
T_4 - Water spray
T_5 - Absolute control

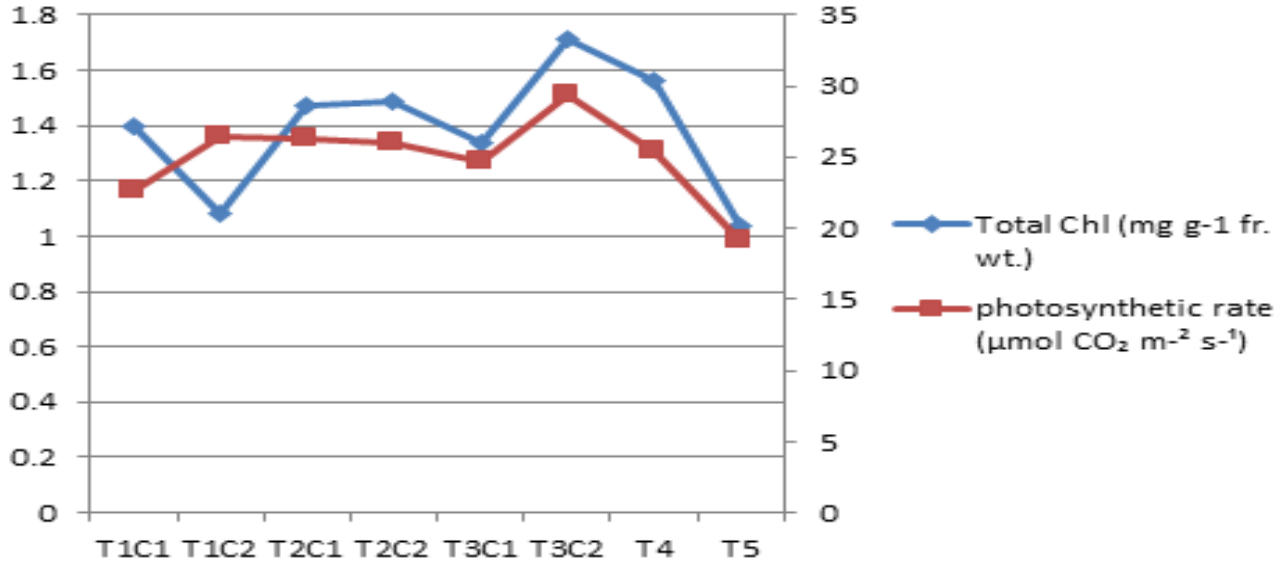

Fig 3: Relation between photosynthetic rate and chlorophyll content under open condition at reproductive stage.

T_1C_1 - Glycine betaine - 10ppm T_1C_2- Glycine betaine - 20 ppm
T_2C_1 - Ascorbic acid - 50 ppm T_2C_2 - Ascorbic acid - 100 ppm
T_3C_1 - Nativo 75 WG - 50 ppm T_3C_2 - Nativo 75 WG - 70 ppm
T_4 - Water spray T_5 - Absolute control

Difference in days between harvest and 50% flowering indicates the grain filling period which an important parameter is in deciding the thousand grain weight and yield. In the present study the grain filling period decreased under 100% solar radiation when compared to 80% solar radiation (Fig 2). This may be one of the reasons for contributing the higher yield in crops grown under 80% solar radiation.

Days to harvest: Plants under reduced solar radiation attained early harvestable maturity and harvested early (112 DAT) but the plants grown under open condition harvested at 116 DAT (Table 1). Mean data in Table 6 show that though the two growing conditions revealed a significant effect on days to harvest, the different treatment effect was non-significant for this phenological character. Variation in grain filling period due to foliar application of stress alleviating chemicals was also observed. Treatment *Nativo* 70ppm could enhance the grain filling period up to 43 days under both condition which contributed maximum grain yield also. Control plants took only 37 days for grain filling under 100% solar radiation where as it was prolonged to 39 days under 80% solar radiation. The ability of *Nativo* at high concentration to prolong grain filling period of 6 days compared to absolute control may be due to its ethylene inhibition activity to decrease senescence and retain greenness in crops. Previously Grossmann *et al.* (1999), also linked strobilurin with delayed senescence of leaves which consequently prolonged photosynthetic activity of green tissue and leads to better management of crop stress. This may be also due to the property of *Nativo* to alter the physiological characters like retention of green leaf tissue, increase in endogenous cytokinin and auxin level, inhibition of ethylene biosynthesis, increase in CO_2 assimilation, better N assimilation, increase in water use efficiency and harvest index as reported by Nagajothi and Jeyakumar (2014). In another study Nativo 75WP significantly improved the growth of ground nut by improving root length and total dry matter accumulation at different stages of growth (Priya *etal*., 2015)

CONCLUSION

Significantly higher UV-B (2.18 Wm^{-2}) and PAR (1786 $\mu molm^{-2}s^{-1}$) was recorded during March-2016 under 100% solar radiation compared to 80% solar radiation. Observations on various phenophases of growth indicated that grain filling period (difference between days to harvest and days to 50% flowering) decreased under 100% UV-B radiation. But, the application of *Nativo* 70ppm could enhance the grain filling period compared to other chemical treatments and also it could possess moderate tillering which consequently contributed to more yield. UV-B stress alleviating chemicals could enhance the plant height, tiller number compared to absolute control under both 100 and 80% solar radiation.

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