Phytohormones induced amelioration of high temperature stress in *Brassica juncea* (L.) Czern & Coss

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ABSTRACT

Inconsistent environment imposes constraints which lead to many reversible and irreversible metabolic and physiological changes in plants. High temperature is among the major environmental factor that limits crop productivity in many area of the world. *Brassica* being a *rabi* crop of arid and semi arid region, its sowing depends upon rain. Heat stress prevailing during sowing time reduces seed germination and causes seedling mortality. This causes a lot of economic loss to farmers. The experminent was conducted with the objective to examine the role of hormones in alleviating the effect of heat stress on seedling mortality. Phytohormones or many plant growth regulators have been reported to play an important role in alleviating detrimental effect of heat stress. But, direct studies on role of phytohormones in mitigation of heat stress effects in terms of seedling mortality in *Brassica juncea* have not been comprehensiverly worked out. Counted seeds were soaked in different concentration of hormones viz: Auxin (500, 250, 100, 50 µM), Gibberallic acid (500, 250, 100, 50 µM), Kinetin (500, 250, 100, 50 µM), Abscisic acid (500, 250, 100, 50, 10, 5, 1, 0.5 µM) along with un-soaked control. The seedlings were raised under optimum temperature (25$\pm$0.5^{O}C) and then these were exposed to heat stress(47.5$\pm$0.5^{O}C).Time taken to seedling mortality was used as the criteria to screen thermotolerant genotypes. Longer the time taken by any treatment, more that treatment will be effective in mitigation of heat stress effects. Data reveal that soaking seeds in 100 µM IAA, 100 µM GA, 50 and 100 µM Kinetin and 0.5 &1 µM ABA were effective for mitigating the effect of heat stress. The significant observation was that both growth promoting and growth retarding hormones were effective in mitigation of heat stress effects. The role of growth promoting hormone in the mitigation of heat stress was at a concentration which was otherwise lethal or toxic to its growth at seedling stage.

Key words: Phytohormones – Thermotolerance - *Brassica juncea*.

INTRODUCTION

High temperature is among the major environmental factor that limits crop productivity in many area of the world. Frequency and severity of hot, dry climate may increase in future as global warming intensifies. Phytohormones or many plant growth regulators viz: ethylene (Biddington and Robinson, 1993; Dhaubhadel et al., 1999, Karagezov, et al., 2002); cytokinin (Arnison et al., 1990, Sayed,1999; salicylic acid (Zhou and Leul, 1999) have been reported to play an important role in alleviating detrimental effect of heat stress. Due to tropical environment of India, the effect of heat stress is very much harmful. *Brassica* being a rabi crop of arid and semi arid region, its sowing depends upon rain. Heat stress prevailing during sowing time reduces seed germination and causes seedling mortality. Therefore, crop is to be re-sown many a times before a final successful crop is taken. This causes a lot of economic loss to farmers. Looking into the seriousness of the problem, the experminent was conducted with the objective to examine the role of hormones viz: Auxin (IAA), Giberallic Acid (GA), Kinetin (Kin.), and Abscissic Acid (ABA) in alleviating the detrimental effect of heat stress on seedling mortality.

MATERIALS AND METHODS

The objective of the experiment was to know if seedlings soaked in various hormonal concentrations can ameliorate heat stress affects. Counted seeds of *B. juncea* cv. RH-30 were soaked in different concentration of hormones viz: Auxin, Gibberallic acid, Kinetin (500, 250, 100, 50 µM), and Abscissic acid (500, 250, 100, 50, 10, 5, 1, 0.5 µM) for 4 hours along with un-soaked control. Seeds were rinsed with water, air dried and sown in plastic trays (22 x 17 x 8.5

cm l.b.h) having 6.0 kg sandune soil. Each tray was marked into 6 rows and each row had 5/6 spots as desired. Five seeds of each genotype were sown at each spot. Sowing of genotypes was done in complete randomized design (CRD) and replicated thrice. Boxes were kept in seed germinator maintained at 25^0C and 70% relative humidity. Five days after sowing (5 DAS) these seedlings were exposed to high temperature(47.5+0.5^{O}C) at 30% relative humidity. Time taken to 50% seedling mortality was recorded (Table 1). Longer the time taken by a genotype to 50% seedling mortality, more a treatment would be effective in mitigation of high temperature stress.

RESULTS

Data (Table 1) indicate that soaking seeds in 50, 100 and 250 µM IAA delayed 50% seedling mortality by 30 min., 1 h.-20 min.and 40 min. respectively over unsoaked control. However, at 500 µM concentration it was hastened by 40 min. Soaking seeds in GA delayed 50% seedling mortality by 30 min. and 1 h.-30 min. over control at 50 and 100 µM concentrations respectively. Higher concentration of GA (500µM) was harmful in this regard as mortality was hastened by 30 min. Soaking seeds in Kinetin delayed 50% seedling mortality by 1 h.-40 min., 2 h.-00 min. and 30 min. at 50, 100 and 250 µM concentrations respectively. However, at 500 µM concentration it was hastened by 30 min. Kinetin in general was found to be relatively more effective than either IAA or GA. The most effective concentrations of Kinetin was 100 µM followed by 50 µM. Soaking seeds in ABA delayed 50% seedling mortality by 1 h.-50 min. at 0.5 and 1.0 µM concentration and 1 h-00 min. at 5 µM concentration. Remaining higher concentrations were deliterious in this regard.

Table 1. Effect of phytohormones on time taken (h.-min.) to seedling mortality at high temperature (47.5±0.5^{0}C) in *B. juncea* var. RH-30.

Conc. of hormones	Time taken to 50% seedling mortality (h.-min.)			
(µM)	IAA	GA	Kinetin	ABA
Control	3-10±0-15	3-10±0-09	3-20±0-10	3-00±0-17
0.5 µM	-	-	-	4-50±0-11
1 µM	-	-	-	4-50±0-15
5 µM	-	-	-	4-00±0-10
10 µM	-	-	-	2-20±0-20
50 µM	3-40±0-13	3-40±0-10	5-00±0-15	2-30±0-11
100 µM	4-30±0-09	4-40±0-15	5-20±0-28	2-20±0-14
250 µM	3-50±0-11	3-20±0-14	3-50±0-16	2-20±0-09
500 µM	2-30±0-07	2-40±0-18	2-50±0-20	1-50±0-12

"±" denotes standard error. Dash (-) indicates that these conc. were not used.

The delay of seedling mortality by about 2 h.by soaking seeds in Kinetin is extremely helpful in practical field conditions, as high temperature in field conditions prevails for a maximum period of about 4hrs. & delay in seedling mortality for 2hrs. by hormonal application may escape seedling mortality as the temperature starts decreasing in the afternoon and that may be non lethal. The other specific advantage of hormonal application to *Brassica* lies in the fact that this being small seeded crop needs relatively lesser amount of hormonal solution for soaking. Therefore soaking seeds in hormone may be very effective practical approach to mitigate the detrimental effects of high temperature stress.

DISCUSSION

One of the major objective of the present studies was to examine if hormones could overcome the detrimental effects of heat stress. Therefore, soaking seeds in hormone solution costing a little might be a very effective approach to mitigate heat stress effects. Data reveal that though any of the hormones under studies (at a particular concentration) can be used for the mitigation of high temperature stress, growth promoter hormones are better suggested than growth retardents. In most of the earlier studies growth retarding hormones have been used. The

present studies emphasize to use higher concentrations of growth promoting hormones which though initially act as growth retardants in terms of seedling growth but impart thermotolerance.The role of these hormones at other ontogenetic stages however needs to be workerd out. Various workers have studied the role of plant growth regulators/hormones in alleviating the effect of heat stress in many crop species viz: ethylene in Brussels sprouts (Biddington and Robinson, 1991, 1993); 24- brassinolide in *Brassica napus* (Dhaubhadel et al., 1999). salicylic acid in mustard (James et al., 1998), beans (Zhang et al., 2000).

CONCLUSION

Soaking seeds in 100 μM IAA, 100 μM GA, 50 and 100 μM Kinetin and 0.5 &1 μM ABA were effective for mitigating the effect of heat stress.

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