Bangladesh J. Bot. **45**(2): 433-440, 2016 (June)

OPTIMIZATION OF CHILLING INDUCED GERMINATION TRAITS IN WHEAT BY SODIUM NITROPRUSSIDE APPLICATION

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Key words: Wheat, Germination, Chilling stress, Nitric oxide

Abstract

To investigate the role of nitric oxide in relieving chilling induced damages of wheat (*Triticum aestivum* L.) during early germination, three factorial experiments were made in a completely randomized design for two consecutive years with three replications. Three concentrations (0, 10^{-4}, 10^{-5} molar) of sodium nitroprusside were used as nitric oxide donor to examine the ability of nitric oxide seed presoaking in optimizing germination traits. All the traits revealed highly significant increase by the priming except for mean germination time and coefficient of velocity of germination that showed significant decrease. Results of germination traits revealed Chakwal-50 and Uqab-2002 and Faisalabad-2008 tolerant to chilling stress with nitric oxide priming.

Introduction

Nitric oxide (NO) has gained important position in plant science, and has multifunctional role in the growth and development of plant besides regulation of large spectrum of plants' cellular mechanisms. The role of NO in producing tolerance in plants to abiotic stress has established much consideration in the last few years. Studies suggest that NO has the potential to induce tolerance in plants against different environmental stresses. It is effectively involved in numerous physiological processes; though, there has been a lot of disagreement concerning the mechanisms by which nitric oxide can reduce the abiotic stress. It has been accepted that NO plays a crucial role in the varied physiological functions of plants (Libourel *et al.* 2006, Zhao *et al.* 2009).

Cold- or low temperature stress is a major environmental factor affecting plant growth and yield resulting considerable loss to crops (Xin and Browse 2000, Sanghera *et al.* 2011). Chilling damage is a severe problem in many plant species during germination and early seedling growth. Wheat experiences diverse environmental stresses including cold temperature stress during its growth phases that adversely affect its germination, growth and productivity (Bohnert *et al.* 1995, Cai *et al.* 2011). It is therefore important to find out stress resistance varieties of wheat and different strategies that make wheat resistant to such stresses. The present study was planned to test the germination ability of different wheat varieties in cold stress environment with varied concentrations of NO donor and to select best resistant variety and treatment for cold hit areas.

Materials and Methods

Seven wheat (*Triticum aestivum* L.) varieties, *viz*., NARC-2011 (V_1), AAS-2011 (V_2), Punjab-2011 (V_3), Faisalabad-2008 (V_4), Uqab-2002 (V_5), Chakwal-50 (V_6) and Lasani (V_7) were used to test their ability to respond against cold stress with and without NO priming. For this seeds after soaking for five hours in three concentrations (0, 10^{-4} and 10^{-5} molar) of sodium nitroprusside (SNP) as NO donor, were grown in Petri dishes lined with filter paper. Petri dishes having seeds of

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relevant treatments and varieties were placed in respective growth conditions according to completely randomized design. Germination process of the seeds started from 3rd day of sowing and germination was screened till 15 days to derive the following germination traits.

Mean daily germination (MDG), germination speed (GS), coefficient of velocity of germination (CVG), mean germination time (MGT), germination rate index (GR), germination index (GI) and final germination percentage (FGP) were determined by using the formulae as described in the AOSA (1983). Analysis of variance was used to test the significance of the data and then LSD was performed to compare differences among the treatments (Steel *et al.* 1997).

Results and Discussion

Interactions of wheat varieties with different sodium nitroprusside (SNP) concentrations and varied growth conditions showed significant ($p \leq 0.05$) results for mean daily germination during both the years (Fig. 1). Results are in conformity with Sharafizad *et al.* (2012) who reported decrease in MDG in stress conditions as compared to control and increase in mean daily germination with increase in SA concentration. Variability in germination by varieties was also reported by others (Reddy and Vaidyanath 1982, Mondal *et al.*1998).

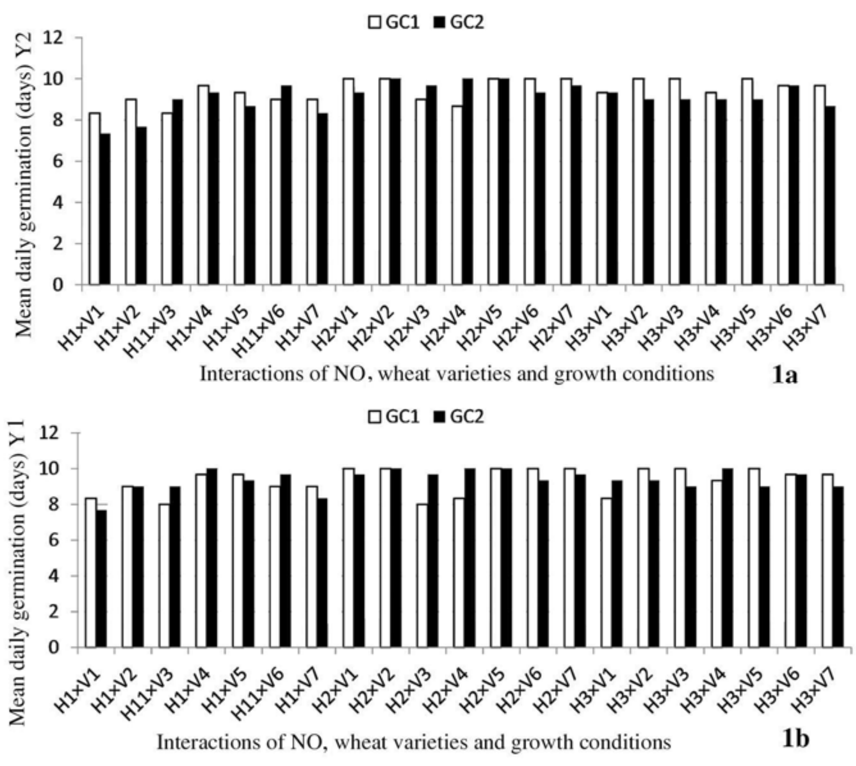

Fig. 1. Variations in mean daily germination by stress and NO priming. GC1 and GC2 are control and chilling growth conditions, respectively and Y1 and Y2 indicate the results of first year (2012-2013) and second year (2013-2014), respectively.

Interactions of wheat varieties with different SNP concentrations and growth conditions revealed little variations in germination rate at different growth conditions and different seed priming, however non significant ($p \leq 0.05$) during both the experiments (Fig. 2). Similar results such as increased germination speed values by increased level of drought stress as well as of hormone was reported by Naderi *et al.* (2013). In the present study seed priming in stressed growth condition (GC) showed highest germination speed values which are consistent with the findings of Zare *et al.* (2011) who reported germination speed of primed seeds more in stressed GC as compared to unstressed one.

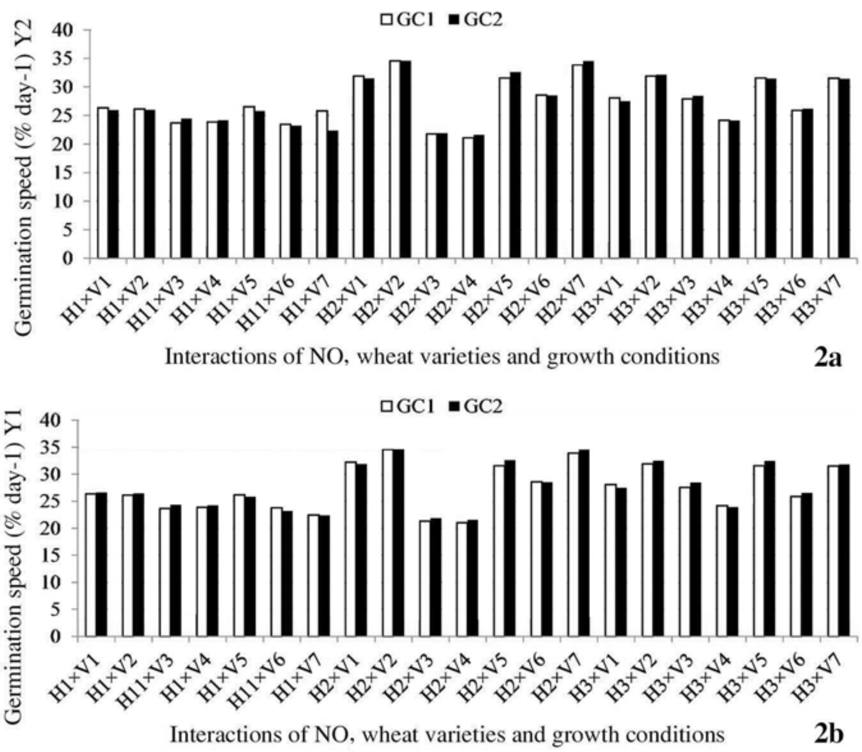

Fig. 2. Variations in germination speed by stress and NO priming. GC1 and GC2 are control and chilling growth conditions, respectively and Y1 and Y2 indicate the results of first year (2012-2013) and second year (2013-2014), respectively.

Comparison of wheat varieties with different hormonal concentrations and in different growth conditions revealed variations in coefficient of velocity of germination values however, non-significant ($p \leq 0.05$) during both the experiments (Fig. 3). In this study coefficient of velocity of germination values was found to vary a little in different GCs and samples showed highest coefficient of velocity of germination values in unstressed GC. After various SNP treatments highest coefficient of velocity of germination was obtained from samples primed with 0 M SNP as compared to both 10^{-4} and 10^{-5} M SNP priming. Similar findings were reported by Naderi *et al.* (2013). They found highest values of coefficient of velocity of germination in unstressed conditions as compared to stressed GC.

Interactions of wheat varieties with various concentrations of SNP and their comparison in both chilled and unchilled GC showed that mean germination time value of variety is affected by SNP concentrations. Though, GC has the little capacity to change the mean germination time of plants as nonsignificant ($p \leq 0.05$) variations were found in the present experiment in varied GC (Fig. 4).

The present results are in accordance with Elouaer and Hannachi (2012), Sharafizad *et al.* (2012) and Anbumalarmathi and Mehta (2013). They reported that increasing level of stress significantly reduce mean germination time (MGT) and samples with distilled water treatment showed highest MGT. Moreover, they stated increasing concentrations of hormone and stress decrease the speed of germination.

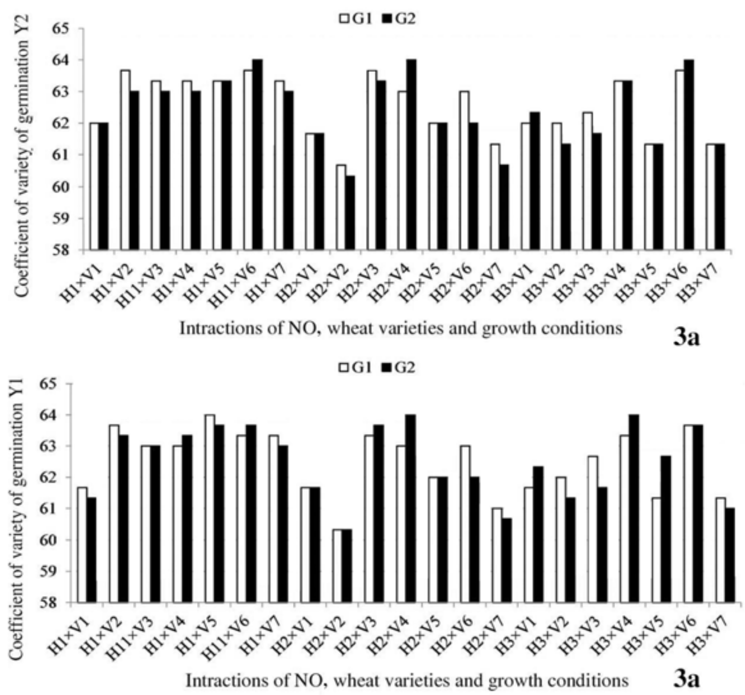

Fig. 3. Variations in coefficient of velocity of germination by stress and NO priming. GC1 and GC2 are control and chilling growth conditions, respectively and Y1 and Y2 indicate the results of first year (2012-2013) and second year (2013-2014), respectively.

Interactions of wheat varieties and NO in varied GC showed that GC can affect values of germination rate index (GRI) in wheat varieties, however SNP treatments could mitigate the effect of GC on GRI in wheat varieties (Fig. 5). The present results are similar to Zaman *et al.* (2012). They reported decrease in GRI value by increasing stress level and increased value by increased level of seed priming. Highest values of GRI by Faisalabad-2008 are due to its genetic makeup which enabled it to tolerate all the growth conditions. This is in consistent with findings of Anbumalarmathi and Mehta (2013).

Comparison and interaction of wheat varieties in chilled and unchilled GC revealed variations in germination index (GI) values though non significant at ($p \leq 0.05$) (Fig. 6). The present results are in conformity with previous findings of Ling *et al.* (2005) and Elouaer and Hannachi (2012). They found increased values of GI in control conditions and even in stressed conditions. Increased GI was reported by exogenous applications of chemicals. Faisalabad-2008 and UQAB-2011 showed maximum GI values and Punjab-2011 showed minimum GI values. This might be due to variation in their internal metabolisms because of different genetic makeup as varied results of germination indices revealed by rice varieties as reported by Reddy *et al*. (1982).

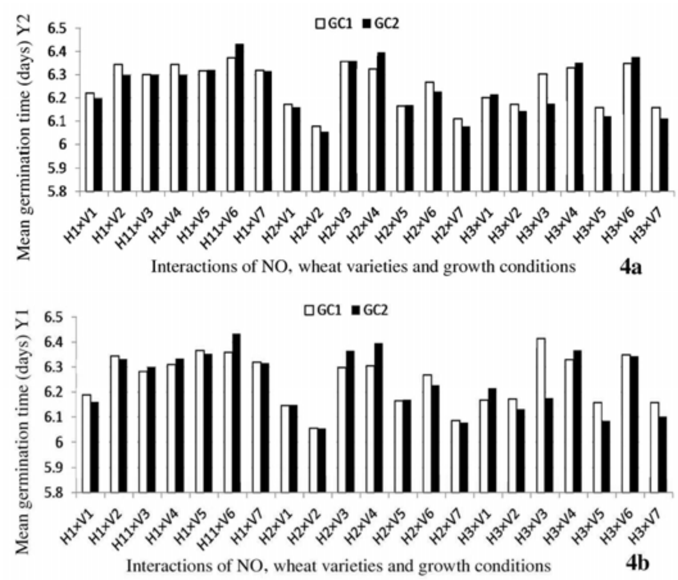

Fig. 4. Variations in mean germination time by stress and NO priming. GC1 and GC2 are control and chilling growth conditions, respectively and Y1 and Y2 indicate the results of first year (2012-2013) and second year (2013-2014), respectively.

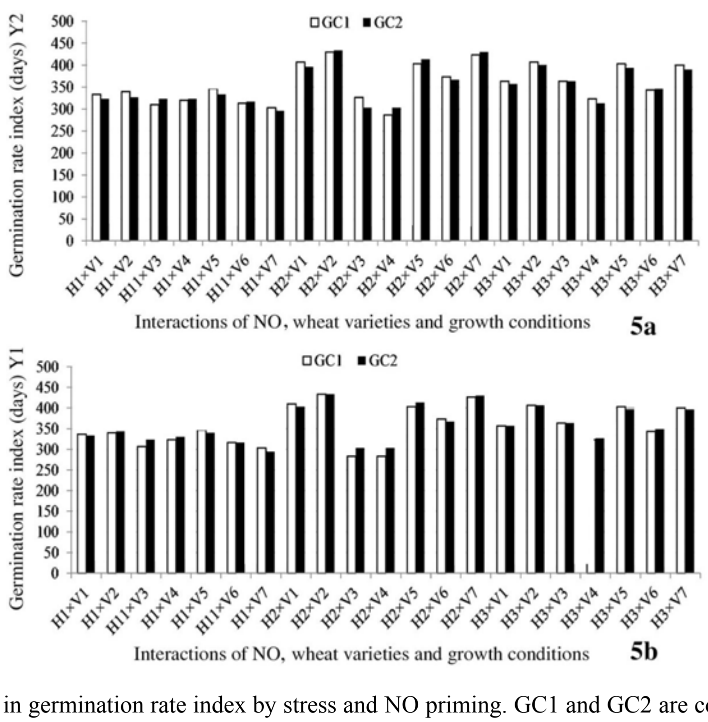

Fig. 5. Variations in germination rate index by stress and NO priming. GC1 and GC2 are control and chilling growth conditions, respectively and Y1 and Y2 indicate the results of first year (2012-2013) and second year (2013-2014), respectively.

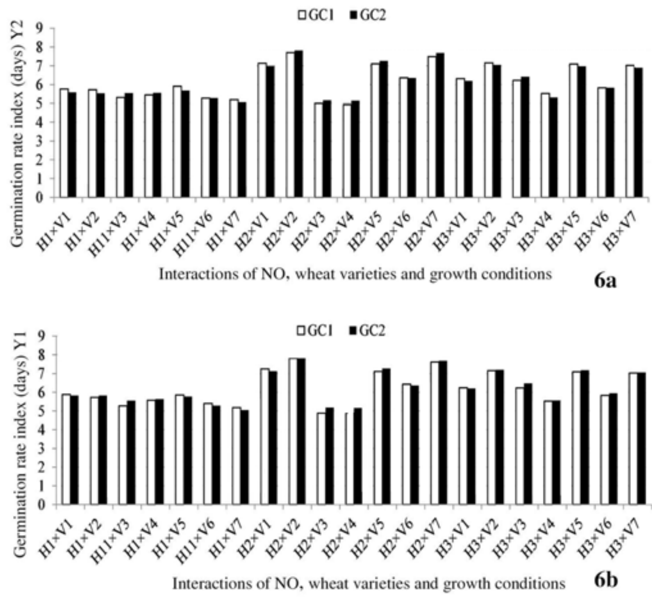

Fig. 6. Variations in mean germination index by stress and NO priming. GC1 and GC2 are control and chilling growth conditions, respectively and Y1 and Y2 indicate the results of first year (2012-2013) and second year (2013-2014), respectively.

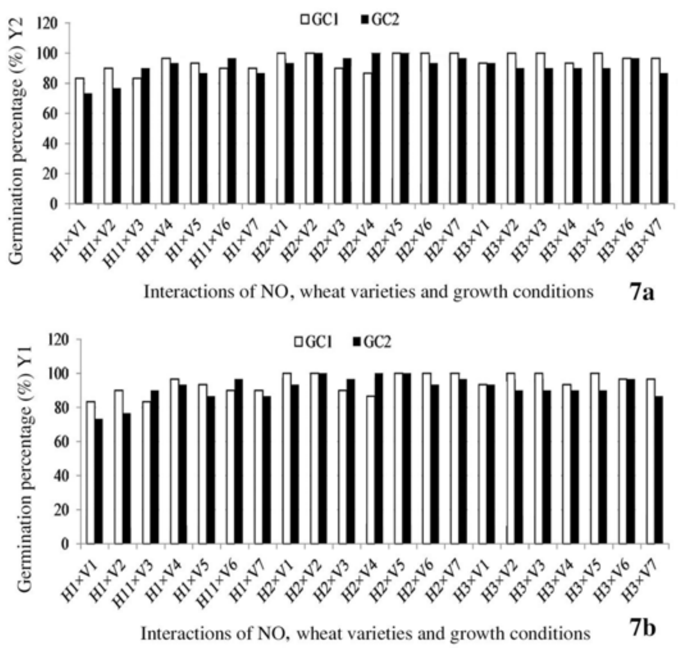

Fig. 7. Variations in final germination percentage by stress and NO priming. GC1 and GC2 are control and chilling growth conditions, respectively and Y1 and Y2 indicate the results of first year (2012-2013) and second year (2013-2014), respectively.

SNP priming contributed in increasing FGP values in both stressed and unstressed GC. This is in agreement with the results of many previous workers (Ansari and Sharif Zadeh 2012, Chen *et al*. 2005). Highest final germination percentage values from Lasani, Chakwal-50, Uqab-2002, Faisalabad-2008 and Narc-2011 are due to their genetic difference which corresponds to varied tolerance level in varieties. Variations in different parameters by varieties in same conditions and treatments were also reported by Ranganayakulu *et al.* (2013).

Results showed that stress has significant ability to decrease the germination indices of wheat, though nitric oxide can increase germination in stress as well as control conditions. This study has demonstrated that values of germination indices revealed from varied seed priming in same wheat variety was different in stressed growth conditions in addition to unstressed growth conditions.

Acknowledgments

This work was a part of Ph.D. thesis of the corresponding author (AB). She thanks the faculty members and staff, Department of Botany, University of Azad Jammu and Kashmir for their cooperation.

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(Manuscript received on 28 October, 2015; revised on 24 December, 2015)