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Chilling Effect on Germination and Seedling Vigour of Some Cultivated Species of *Gossypium*

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Abstract: The study was conducted to assess the chilling effect on germination, hypocotyl and root length of two cotton cultivars. Hundred seeds of each *Gossypium arboreum* A2 genome (G_1) and *Gossypium hirsutum* AD-1 (G_2) were chilled at 0 °C for 0, 24, 48, 72 and 96 h and then placed in incubator at 32°C. Germination percentage significantly decreased with the increasing chilling period. However, the effect was pronounced on G_1 than G_2. The highest hypocotyl length after 96 h of chilling treatment was 64 mm for G_1 and 91 mm for G_2, under 48 h of chilling treatment. Root lengths of both varieties were maximum under the treatment of 24 h of chilling after 96 h. On the basis of germination percentage, hypocotyl and root length, it may be inferred that G_2 was more cold tolerant variety than G_1.

Key words: Chilling, *Gossypium* species, germination, hypocotyl length, root length

Introduction

Cotton is a major fiber crop and plays an important role in the economy of Pakistan. During 2001-2002, it was cultivated on 0.31 m ha with the total production of 10.9 million bales (Anonymous, 2000-2001). It also provides raw material to domestic industry comprising textile mills, ginning factories and oil expelling units.

Germination of cotton is sensitive to temperature (Baloch *et al.*, 1999; Ahmad, 1999). The chilling effect is more pronounced in cotton than other crop species. Chilling injury occurs in cotton when the temperature drops below 15°C for a few hours during the first few days of germination (Lauterbach *et al.*, 1999). Cotton seed is not uniformly sensitive to chilling at all stages of germination. In addition to immediate effect on emergence rate and stand development, chilling may also alter growth, fruiting pattern and yield (Edmisten, 2001). Cotton species is ranked as excellent, good, fair and poor cold tolerance showing 80, 70-80, 50 and below 50 imbibitional and metabolic emergence percents, respectively (Duesterhaus *et al.*, 1999). Several cotton varieties with enhanced germination and seedling growth at low temperature have been previously identified (James *et al.*, 2002). They compared different cotton varieties to low temperature sensitive varieties commonly grown on the Southern High Plains of Texas. They reported that antioxidants (for example glutathione) are responsible for cold tolerance. However, Barry *et al.* (2002) reported that enhanced chilling tolerance that has been demonstrated during short term laboratory treatments of unacclimated transgenic plants over expressing antioxidants may not be indicative of their performance in the field. Dmytro (2002) compared three transgenic lines with wild types against temperature less than 15°C. The results affirm the important role of increased photochemistry in PS II photo-protection observed in the transgenic plants. Cold tolerant cotton genotypes would allow earlier planting, thus producing more profit from reduction in sowing rates and obtaining greater yields of high quality fiber (Schulze *et al.*,1997). Keeping in view the facts that different cultivars respond differently towards chilling stress, it is imperative to quantify the effects of cold injury on growth parameters of cotton. Therefore, the specific objective of this study was to evaluate the chilling effect on germination and hypocotyl and root length of two cotton cultivars.

Materials and Methods

The laboratory study was conducted in the Cytogenetics Section, Central Cotton Research Institute, Multan during 2001-2002. Hundred acid delinted and sterilized seeds of two cotton cultivars, *Gossypium arboreum* A_2 (G_1) and *Gossypium hirsutum* AD-1 (G_2) were chilled at 0°C for 0, 24, 48, 72 and 96 h. Twenty seeds of each cultivar were put in sterilized glass petridishes. Four sets of seeds were placed in the refrigerator. Treated and untreated seeds were put on moistened filter paper in rows, each containing ten seeds. After placing seeds the filter papers were rolled up and put them in sterilized glass beakers containing some amount of distilled water at the bottom for the germination and growth process. Then the seeds were incubated in dark at 32°C. The experiment was conducted in aseptic condition. The observations regarding germination, hypocotyl and root length were recorded after every 24 h till 96 h. Root length was measured following the techniques of Tennant (1975). Data were statistically analyzed by Steel and Torrie (1980). Germination percentage was calculated by the formula of Ahmad (1999).

Results and Discussion

Germination percentage: The increasing chilling period significantly decreased the germination of both the varieties (Table 1). However, the effect was more pronounced on G_1 than G_2 indicating that G_2 is more cold tolerant than G_1. Under all treatments the germination was higher in case of G_2. Maximum germination (80%) of G_2 can be attained under chilling period of 24 h. Edmisten (2001) reported that temperature below 40°C retarted the growth of seedlings. However, James *et al.* (2002) reported enhanced germination at low temperature. This may be due to presence the antioxidants pools (ascorbate and glutathione) enzymes which are responsible to enhance the germination in cold tolerant cotton varieties. Similar results of low germination under low temperatures were reported by others (Ahmad, 19990; Schulz *et al.*, 1997; Baloch *et al.*, 1999).

Hypocotyl length: The chilling period decreased the hypocotyl length for both cultivars (Table 2). The length of hypocotyl increased with the increasing interval of measurement from 24 and 96 h. Maximum hypocotyl length of G_1 was 64 mm under the treatment of 24 h of chilling after 96 h while minimum length was 22 mm under the highest level of chilling (96 h) with 49% decrease in hypocotyl length as compared to control (Table 3). Maximum hypocotyl length of G_2 was 91 mm under the treatment of 48 h of chilling after 96 h and minimum length was 34 mm under highest chilling effect of 96 h, with 37% decrease in hypocotyl length as compared to control. Edmisten (2001) reported that cotton is sensitive to temperatures below 10°C when it is absorbing water to begin germination. According to temperature below 10°C caused growth retardation for weeks into the season. Baloch *et al.* (1999) also reported that chilling retarted growth of cotton. However some varieties of cotton (*G. hirsutum* L.) may prove under chilling conditions. Similar results were reported by Schulz *et al.* (1997) and Duesterhaus *et al.* (1999). The mechanisms responsible to cold tolerance were proposed by various researchers. Dmytro *et al.* (2002) reported that antioxidant enzymes were responsible for chilling tolerance.

Table 1: Effect of chilling for different periods on germination percentage of two cotton cultivars

Cultivar	Chilling period (h) 0	24	48	72	96
Gossypium arboreum A2 genome (G_1)	85a	75b	70bc	70bc	65c
Gossypium hirsutum AD-1 (G_1)	85a	80a	75b	70b	70b

Figures bearing the same letter(s) in the rows are not statistically different at P<0.05

Root length: The chilling period also decreased the root length of both cultivars (Table 3). In contrast to hypocotyl, root length was increased with the increasing interval of measurement from 24 to 96 h. Under the treatment of 24 h of chilling after 96 h, the root length was maximum (108 mm) for G_1 but under the highest level of chilling it was minimum (79 mm) with 14% less over control. While for G_2, maximum (111 mm) root length was obtained under the treatment of 48 h of chilling and minimum (91 mm) under the highest level of chilling with 11% decrease as compared to control. Results obtained

Table 2: Effect of chilling for different periods on hypocotyl length of two cotton cultivars

	Cultivar									
	G. arboreum A_2 (G_1)					*G. hirsutum* $(AD)_2$ (G_2)				
	Chilling period (h)									
Hypocotyl length (mm)	0	24	48	72	96	0	24	48	72	96
After 24h	-	-	-	-	-	-	-	-	-	-
After 48h	3b	4a	4a	3b	2c	4a	4a	3b	3b	2c
After 72h	15c	49a	21b	18bc	9d	20b	23a	14c	14c	8d
After 96h	44bc	64a	49bc	36c	22d	54b	55b	91a	49c	34d

Table 3: Effect of chilling for different periods on root length of two cotton cultivars

Root length (mm)	Cultivar									
	G. arboreum A_2 (G_1)					*G. hirsutum* $(AD)_2$ (G_1)				
	Chilling period (h)									
	0	24	48	72	96	0	24	48	72	96
After 24h	3a	3a	4a	4a	2b	2a	1b	1b	1b	1b
After 48h	24c	33b	37a	30b	23c	31a	34a	24b	19c	26b
After 72h	57c	70a	75a	62bc	57c	72b	84a	64c	62c	44d
After 96h	92b	108a	105a	95b	79c	100b	104a	111a	95b	91b

Figures bearing the same letter(s) in the rows are not statistically different at P<0.05

from the experiments conducted in North Carolina, USA showed that germination, growth and the root development were badly affected when that soil temperature dropped to less than 10°C (Edmisten, 2001). Brown (2000) reported that low soil temperature adversely affected stand establishment, altered normal root development and caused cell damage that rendered seedling more susceptible to seedling diseases. Ahmad (1999) summarized the results of experiments conducted at CCRI, Multan and concluded that at low temperatures the root development of cotton is reduced. However, among the cotton varieties, *G. hirsutum* L. was found relatively more cold tolerant than others. Similar results were reported by others (Schulze, 1997; Baloch *et al.*, 1999).

In conclusion, data regarding the germination percentage, hypocotyl and root length in G_2 was ranked more cold tolerant than G_1 because G_2 is inter-specific hybridization of G_1 and wild species of D. genome. Specific characters have been transferred from wild species to G_2.

References

Ahmad, Z., 1999. Pest problems of cotton. A regional perspective. Proc. ICAC-CCRI, Regional Consultation IRM in Cotton. June 28 to July 1, 1999, Multan, Pakistan.

Anonymous, 2001. Government of Pakistan, Economic Advisor's Wing, Finance Division, Islamabad, Pakistan.

Baloch, M.J.A., R. Lakho, H.U. Bhutto and A.H. Baloch, 1999. Genotype x environment interaction analysis of cotton varieties, *Gossypium hirsutum* L. Sindh, Biological, J. Plant Sci., 1: 1-6.

Barry, L., M. Gary, K. Dmytro, P. Paxton, A. Randy and H.A. Scott, 2002. The response of transgenic cotton with elevated glutathione reductase activities to growth under chilling conditions. Web Site: http://academic.bowdoin.edu/bio/faculty/html/logan.shtml.

Brown, P.W., 2000. A Good Planting Forecast. Web Site: Center for IPM NC State University.

Dmytro, K., L. Barry, P. Paxton, A. Randy and H. A. Scott, 2002. The mechanism of enhanced chilling tolerance in transgenic cotton plants with elevated antioxidants enzymes activities. Web Site: http://www.geocities.com/ttu_plant

Duesterhaus, B., N. Hopper, J. Gannaway, G.M. Jividen, P. Dugger and D. Richter, 1999. Development of a Laboratory Screening Test for the Evaluation of Cold Tolerance in Cottonseed Germination. Proc. Beltwide Cotton Conf., 1: 621-623.

Edmisten, K., 2001. Planting Decision. North Carolina Cotton Production Guide. Web. Center for IPM NC State University.

James, M., L. Gingar and H. Norman, 2002. The role of metabolic and enzymic activities in low temperature germination and emergence in several clod tolerant varieties. Web Site:http://www.csrl.ars.usda.gov/

Lauterbach, B., D. Krieg, G. Jividen, P. Dugger and D. Richter, 1999. Fatty acid Composition of Lipid Fractions in Germinating Cotton as Affected by Temperature. Proc. Beltwide Cotton Conf., 1: 564-565.

Schulze, D., N. Hopper, J. Ganraway and G. Jividen, 1997. Evaluation of chilling tolerance in cotton genotypes. Proc. Beltwide Cotton Conf., 2: 745-750.

Steel, R. G.D. and J. H. Torrie, 1980. Principles and Procedures of Statistics. McGraw Hill Book Co. Inc., New York, USA, pp: 1383-1385.

Tennant, D., 1975. Test of a modified line intersect method of estimating root length. J. Appl. Ecol., 63: 955-1001.