Effect of the retardant "Dextril" on the quality of tomato seedlings grown at high temperature conditions

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ABSTRACT:

The effect of different concentrations of growth retardant "Dextril" (C_{11} $H_{18}Cl_2O_7P$) on tomato (*Solanum lycopersicum* c.v Huda F1) seedlings quality was studied, at the Agriculture Faculty of Alexandria - Egypt, on 2010. Tomato seedlings were sprayed when the second true leaf was appeared with "Dextril" at (0.02 – 0.04 – 0.06 – 0.08 – 0.1%) levels, to promote seedlings tolerance to heat stress during summer – autumn period and limit stem growth and elongation.

The results showed that, "Dextril" treatment of (0.02 -0.04 – and 0.06%) levels improved seedlings quality and decreased stem height by 30, 32, and 35% respectively compared to the control, whereas, 0.08 and 0.1% levels showed toxic effects. Treatment with "Dextril" increased as well, stem diameter, fresh and dry weight of shoots, but it did not affect leaf number compared to the control. The results indicate that the spraying with low concentrations of 'Dextril" is promising measure for improving the stress response and developmental characteristics of tomato seedlings grown under high temperature conditions.

Key words: Tomato, seedling, growth retardants, Dextril.

1. INTRODUCTION:

Tomato is the most important vegetable cultivated in greenhouses in the world. It is considered as a main crop in Syria, and it occupies 75% of total greenhouses which count 129000. The technique of seedlings production is as important as crop production, because, most tomato growers use plant seedling and prepare them under protected conditions.

Tomato seedlings are subjects during their production in summer, to a high temperature which cause stem elongation and diameter reduction, and finally, bad seedling quality, they become less tolerant to environmental stress and die after planting.

Plant growth retardants are used to retard the shoot length of plants without changing developmental patterns or evoke phototoxic effects. This has been achieved not only by reducing cell elongation but also by lowering the rate of cell division and regulating the plant height physiologically (Rademacher, 1995, 2000). Most plant growth retardants inhibit the formation of gibberellins (GAs) and can thus be used to reduce unwanted shoot elongation (Singh, 2004; Mansuroglu et al., 2009).

Plant growth retardants are synthetic substances, which inhibit, for a period of time, the elongation of stem and shoots, without irreversible blocking of vital metabolic and developmental processes in plants (Caprita et al., 2005).

The inhibition effects of gibberellins biosynthesis, resulting in internodes shortening, and long term growth suppression of many plants. The activity of growth retardants occur after stem penetration or root uptake following irrigation or rainfall. Flowering can be enhanced in some crops, and intensified leaf greening with a little or no toxicity (Hafeez- ur- Rahman et al., 1989).

The effects of growth retardants vary with plant species, genotype, concentration used, method of application, plant age and various other factors which influence the uptake and translocation of the chemicals (Cathey, 1964).

Growth retardants have some other physiological effects; they could induce the more intense accumulation of compounds that influence taste, color, and flavor, thus improving the quality and the commercial value of the products (Caprita et al., 2005).

Growth retardants are used widely in agriculture, especially, on cereal crops, to prevent their lodging and decrease grain loss at ripening and enhance plant tolerance to environmental stress, without affecting positively growth and production (Likhotshirvo, 2007; Matisiak, 2006; Maciorowski et al., 2006).

Chlormequat and its related commercial compounds: Cycocel and Dextril are the most important growth retardants.

Other growth retardants like uniconazole and paclobutrazol improved cold resistance of Zoysia turfgrass and increased SOD activity and proline concentration (Wang et al., 2013).

Paclobutrazol and uniconazole-p, as well constrained the elongation rate of the leaves and reduced leaf length of young date palm seedling (Cohen et al., 2013). These results suggest the possible future use of growth retardants to reduce trunk height of date palm trees.

Plant height of *Erysimum marshallii* (ornamental plant) was decreased by the growth retardant Cycocel application, whereas B-nine application was not effective in decreasing the plant height. The fresh and dry mass of roots, leaves and stem was decreased by the spray application of both Cycocel and B-nine (Bhat et al., 2011).

Treatment of fruit trees and vegetable seedlings or plants with growth retardants, decreased stem height and increased its thickness (Jacov, 1990; El Shahat, 1990; Bezuglova, 2000).

Branch growth of apple (*Malus sylvestris*), peach (*Prunus persica*) and bear (*Pyrus communis*) trees when treated with growth retardants (200 - 400 ppm) after 2 weeks of blooming, were reduced (Dicks, 1980; Nagy and Tabi, 1982).

Several studies demonstrated that spraying tomato plants with growth retardants improved their capacity to tolerate low temperatures and increased early and total yield (Budekeyana and Temeco, 2007; Budekeyana, 1998; El- Asdoud, 1993; Czapski et al.,1990).

Treatment of two cultivars (No-14 and Riana) of pot grown alstroemeria (cut flower) with different growth retardants (Alar (Daminozide), Chlormequat (Cycocel) and Paclobutrazol (Cultar) resulted in growth reduction and cultivar No-14 took minimum days to bud formation and produced a greater number of cymes by inflorescence (Wazir, 2011).

Treating of tomato, potato (*Solanum tuberosum*), cauliflower (*Brassica oleracea botrytis*), and cabbage (*B. oleracea capitata*) seedlings with growth retardants at (250-1000 mg/l) two alternative times, with 7-10 days intervals resulted in stem shortening and thickness, intensifying leaf greening, improve root system which promote seedling quality without any residual effects in tomato fruits, potato tubers, cauliflower head and cabbage leaves (Malivania et al., 2007; Avakyan, 2000; Hickman et al,. 1999; Genchew and Miller, 1983).

Purpose of the present investigation was to examine the retarding effects of Dextril on tomato seedlings quality and their tolerance to after planting shock.

2. Materials and Methods:

Tomato seeds (*Solanum lycopersicum* c.v Huda F1) were sown in trays containing 50 holes of 65 cm^3 volume filled with peat moss, and were allowed to germinate in the greenhouse at 25 ± 4C°.

When the second leaf was emerged, seedlings were treated with growth retardant "Dextril" at five levels, as following:

1- seedling sprayed with distilled water (control).

2- seedling sprayed with "Dextril" 0.02%.

3- seedling sprayed with "Dextril" 0.04%.

4- seedling sprayed with "Dextril" 0.06%.
5- seedling sprayed with "Dextril" 0.08%.
6- seedling sprayed with "Dextril" 0. 1%.
A completely randomized design was employed for the experimental design, which consists of 6 treatments with 4 repetitions, and 20 seedlings for each replicate.
Seedlings were fertilized twice during growth period with (delta spray) TE+ 20:20:20, (1g/ L of water). They were treated as well with fungicide Previcur – N (Propamocarb hydrochloride) and insecticide lentrek 4 EC (Chlorpyrifos 48% w/v), to prevent infection with fungal diseases and insects.
When seedlings are 40 days old, plant quality was determined by measuring:
1- Seedling height / cm.
2- Seedling stem diameter / mm.
3- Number of leaves by plant.
4- Leaf area (cm^2 / plant).
5- Fresh and dry weight of shoots and roots (g / plant).
6- Degree of adaptation after planting, defined by Andreev (2003):

$K = \frac{\text{No.of survival seedlings}}{\text{Total No.of seedlings}}$, Where: K= the degree of adaptation.

- Scanning electron microscopy, SEM. Trans section of epidermal and cortical cells of tomato control, and tomato treated with Dextril realized by technicians at electron microscopy center- Faculty of Sciences- University of Alexandria- Egypt.

- Statistical analysis realized by using Genstat 5 program.

Temperature degrees (minimal and maximal) were registered during growth period in the greenhouse (Table 1).

Table (1): Maximal and minimal temperatures during growth period.

Date / C°	1st week	2ed week	3ed week	4th week	5th week	6th week
Maximal	34.6	34.8	34.4	35.4	35.6	35.8
Minimal	20.4	20.8	21.2	21	22.2	22.6

Table (1) showed that the mean of maximal temperature (34.4- 35.8) was greater by 6 to 8 C° than the maximum optimal degrees needed for growth, and the minimal temperature was greater as well by 3 to 4 C° than the minimal optim al degrees for growth.

3. RESULTS AND DISCUSSION:

3-1- Effect of "Dextril" on seedling height, stem diameter, number of leaves and leaf area:

Treatment with different concentrations of Dextril significantly affect seedlings quality (Table 2). Lower concentrations of Dextril (0.02 – 0.04 – 0.06%) improved standard characters of seedlings. Plant height was decreased, while stem diameter and leaf area were increased compared to the control. The number of leaves was affected only with high concentrations (0.06- 0.08- 0.1%).

Table (2): Effect of "Dextril" on seedling height, stem diameter, number of leaves and leaf area

Treatments	Seedling height/cm	Stem diameter/mm	Number of leaves	Leaf area/cm^2/plant
Control	18.5^a	3.3a	4.3^a	167^a
Dextril 0.02%	13^b	4.5^b	4.3^a	244^b
Dextril 0.04%	12.5^b	4.5^b	4.2^a	213^c
Dextril 0.06%	12^b	4^c	3.9^b	206^d
Dextril 0.08%	6.7^c	2.5^d	3^c	96^e
Dextril 0.1%	6.5^c	2.5^d	3^c	87^e
LSD 5%	3.5	0.194	0.43	21.4

* Values indicated with same letters are not significantly different.

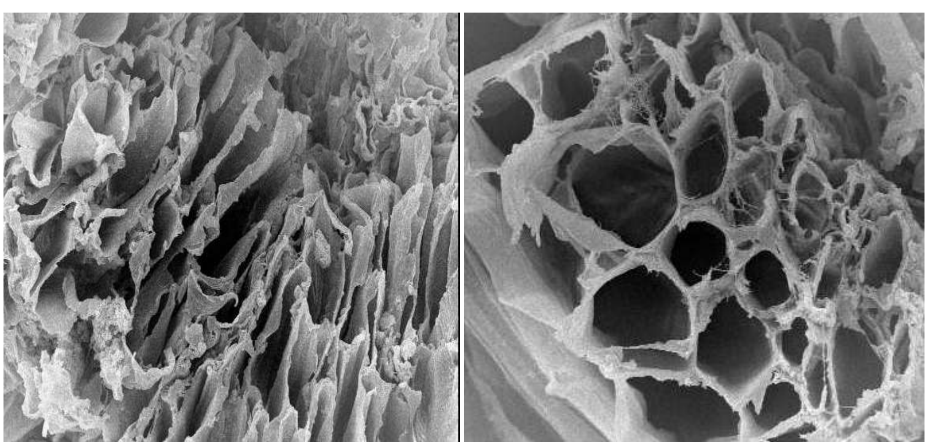
The inhibitory effect of Dextril on plant height may be due to the inhibition of cell division of stem apex as it was demonstrated for other growth retardants like: Chlorocholine Chloride (CCC) on sunflower (*Helianthus annuus)*, (Lovett and Orchard, 1981) and 2,3,5- triiodobenzoic acid (TIBA), on sorghum (*Sorghum sp.*), (Hatley et al., 1985).

The effect of Dextril may be due as well to its effect on gibberellins biosynthesis like other growth retardants which is responsible on stem elongation (Singh, 2004; Mansuroglu et al., 2009).

Dextril effect on stem diameter may be due to the inhibition of longitudinal cell growth and the stimulation of cell width when used in low concentrations (Bezuglova, 2000).

Many works showed that application of growth retardants like MH (Maleic hydrazid) and CCC on sorghum during flower initiation and 7 days after, resulted in the reduction of plant height and leaf area (Mehetre and Lad, 1995), while, foliar application of CCC (500 ppm), significantly increased leaf area per plant as compared to the control.

Foliar application of growth retardant daminozide (400 – 800 ppm) on sunflower genotypes, significantly decrease plant height over control, Saisanker (2001), while stem diameter was not significantly different among treatments. Other authors demonstrated that foliar application of mepiquat chloride (1000 ppm) and lihocin (1000 ppm), significantly decreased plant height and increased the number of leaves and leaf area in cluster bean (*Cyamopsis tetragonoloba*) (Whipker and Mc Call, 2000; Hanchinamath (2005).



Fig(1) Trans section of epidermal and cortical cells of tomato control (right) and tomato treated with Dextril 0.02% (left).Scanning electron microscopy, SEM.

Fig (1) showed that cell sizes of plant control are larger than cells of treated plants with Dextril. The mechanism of reduction in plant height due to application of growth retardants appears to be due to slowing down of cell division and reduction in cell expansion. It has been suggested that, TIBA, cycocel and mepiquat chloride are anti-gibberellin dwarfing agents, leading to a deficiency of gibberellin in the plant and reduce the growth by blocking the conversion of geranyl pyrophosphate to copalyl pyrophosphate which is the first step of gibberellin synthesis (Moore, 1980). Thus, reduction in plant height is due to retardation of transverse cell division particularly in cambium which is the zone of meristimatic activity at the base of the internodes (Grossman, 1990).

It was mentioned above that the increase of stem diameter resulted of Dextril treatment may be due to the inhibition of longitudinal cell growth and the stimulation of cell width when used in low concentrations (Bezuglova, 2000). Fig (1) showed that Cell sizes of plant control were larger than cells of plants treated with Dextril, the Fig (1) showed as well that the number of cells in control are less than these treated with Dextril, it's possible that cell division was inhibited in stem apex but not at epidermal and cortical cells, this may explain the thickness of plant stems treated with growth retardant Dextril.

3-2- Effect of Dextril on shoots and roots fresh and dry weight:

Shoots fresh and dry weight significantly increased with low concentration (0.02%) of Dextril, while, 0.04% and 0.06% of Dextril had no significant effect compared to the control (Table 3).

Dextril (0.02 and 0.04%) enhanced fresh and dry weight of roots compared to the control, whereas, high concentrations had a negative effects as shown in Table (3).

Table (3): Effect of Dextril on shoots and roots fresh and dry weight.

Treatments	Shoot weight /g / plant		Root weight /g / plant	
	Fresh	Dry	Fresh	Dry
Control	3.9^{a}	0.64^{a}	1.15^{a}	0.11^{a}
Dextril 0.02%	4.4^{b}	0.93^{b}	1.67^{b}	0.16^{b}
Dextril 0.04%	4.2^{ab}	0.81^{ab}	1.51^{b}	0.15^{b}
Dextril 0.06%	3.7^{ac}	0.77^{abc}	1.23^{c}	0.11^{a}
Dextril 0.08%	1.8^{d}	$o.38^{d}$	0.45^{d}	0.06^{c}
Dextril 0.1%	1.6^{d}	0.33^{d}	0.36^{d}	0.05^{c}
LSD 5%	0.42	0.22	0.27	0.032

* Values indicated with same letters are not significantly different.

The stimulatory effect of low concentration of Dextril on roots fresh and dry weight may be due to the enhancement of root system growth, so, mineral absorption will be stimulated and this will reflects on shoot growth (Kanade et al., 2002).

Fig (2) Effects of spraying tomato seedlings with Dextril on plant height. 1. Control. 2- Dextril 0.02%. 3- Dextril 0.04%. 4- Dextril 0.06%. 5- Dextril 0.08%. 6- Dextril 0. 1 %.

Also, many studies reported that application of growth retardants like cycocel, significantly increased chlorophyll content compared to the control in groundnut (*Arachis hypogaea*) genotypes (Chetti, 1991). Foliar application of TIBA (50 and 100 ppm), Mepiquat chloride (500 – 100 ppm) and lihocin (500 – 1000 ppm) at 45 days after planting, resulted in increased chlorophyll *a, b* and total chlorophyll (Pravin et al. 2001).

Kanade et al., (2002), reported that foliar application of cycocel (500 and 1000 ppm) in sunflower increased chlorophyll content significantly over control, this stimulation of chlorophyll content by growth retardants may enhance photosynthesis and consequently, improve shoot and root fresh and dry weight.

3-3- Effect of Dextril on adaptation degree of tomato seedlings after planting in field:

Tomato seedlings exhibited differences in their adapting capacity after planting in field. Treatment with Dextril (0.02 and 0.04%) increased seedlings adaptation to 100% compared to the control 90% (Table 4).

Table 4: Effect of Dextril on adaptation degree of tomato seedlings after planting in field:

Treatments	Adapting degree %	N.of days after planting to form new leaf
Control	90	5
Dextril 0.02%	100	4
Dextril 0.04%	100	4
Dextril 0.06%	90	4
Dextril 0.08%	30	8
Dextril 0.1%	30	8

High concentrations of Dextril (0.08 and 0.1%) decreased seedlings adaptation to planting. Otherwise, new leaf was formed on the plant after 4 days of planting compared to the control (5 days).

The effect of growth retardants in decreasing stem height and increasing stem diameter may produce a vigor seedling more adaptable to field conditions. Otherwise, the stimulation of root system by Dextril treatment may as well enforce the seedling stability in the soil and increase the adaptation to field environments.

It was demonstrated that treatments with growth retardant cycocel (1500 ppm) recorded higher total phenols after 60 days (Kashid, 2008); the enhancement of plant phenols may increase the lignifications of stem cell walls, and in consequence, improve the strength of seedlings to support field planting.

Singh and Kaur (1980), reported that phenols play a paramount role in reproductive development and growth of mung bean (*Vigna radiate*). Phenols play a very important role in host plant interactions and it also imparts disease resistance in the plant system.

4. CONCLUSION:

This investigation has produced results suggesting that Dextril could be used for enhancing the tolerance of tomato seedlings to high temperature stress. Treatments with low concentrations (0.02 and 0.04%) of the retardant were found beneficial for controlling the growth and for improving the overall quality. The obtained data have strong potential for practical application at field conditions.

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COMPETING INTERESTS:

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS:

Author [1,3] performed the experiences and participate in preparing this paper and statistical analysis. Author[2] performed the literature and results discussion and the arrangement of the paper.

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