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Effect of chlorocholine chloride on growth, morpho-physiology and yield of tomato at different moisture levels

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ABSTRACT

An experiment was conducted at Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka to study the effect of Chlorocholine chloride (CCC) on growth, morpho-physiological parameters and yield of tomato at different moisture levels. The experiment consisted of three levels of Chlorocholine chloride viz.,F_0 = Foliar spray with water (control), F_1 = Foliar spray with 1000 ppm CCC and F_2 = Foliar spray with 2000 ppm CCC and three levels of moisture levels as; I_0 = 100% ET (Evapotranspiration) moisture, I_1 = 80% ET moisture and I_2 = 60% ET moisture. The two factor experiment was laid out in a Completely Randomized Design (RCBD) with 3 replications. In case of ET moisture levels, the highest fruit length (6.11 cm), fruit diameter (6.82 cm) and the highest total fruit weight plant-1 (1.23 kg) were recorded from 80% ET moisture and whereas for the highest number of fruits sets plant-1 (29.11), highest fruit length (6.40 cm), highest fruit diameter (6.73 cm) and the highest total fruit weight plant-1 (1.48 kg) were found with1000 ppm CCC. Application of 80% ET moisture and foliar spray of 1000 ppm foliar spray of CCC elicited fruit length (6.81 cm), diameter of fruit (7.21 cm) and total fruit weight plant-1 (1.27 kg) the highest yield compared to other treatment and seems to be the best combination for tomato production.

Introduction

Tomato (*Solanum lycopersicum*) belongs to the family solanaceae is one of the most important, popular and nutritious vegetable in Bangladesh. It ranks 3rd in terms of world vegetable production (FAO, 2007). It is the top listed canned vegetables (Choudhury et al., 1997). Tomato contains lycopene pigment which is a vital anti-oxident that helps to fight against cancerous cell formation as well as other kind of health complications and diseases (Kumavat and Chaudhari, 2013). Tomato is one of the most highly praised vegetables consumed widely and it is a major source of vitamins and minerals. It is one of the most popular salad vegetables. It is widely employed in cannery and made into soups, conserves, pickles, ketchup, sauces, juices etc. Tomato juice has become an exceedingly popular appetizer and beverage. The well ripe tomato (per 100 g of edible portion) contains water (94.1%), energy (23 calories), calcium (1.0 g), magnesium (7.0 mg), vitamin A (1000 IU), ascorbic acid (22 mg), thiamin (0.09 mg), riboflavin (0.03 mg) and niacin (0.8 mg).At present Bangladesh occupies about 27 thousand acre of land and production of tomato is about 360 thousand metric ton (BBS, 2014). The average yield of tomato in Bangladesh is very low (7.42 t/ha) in comparison with that of other countries with the average yield of52.82t ha-1 in Japan, 63.66t ha-1 in U.S.A, 30.39 t ha-1 in China, 15.67t ha-1in India (FAO, 2007). Chlorocholine chloride (CCC) Known as cycocel, is a plant growth retardant which causes plants to be compact and stardy, with dark green leaves and shortened internodes and petioles. Michniewiecz and Kertzer (1965) found that tomato plants treated with CCC showed increased resistance to frost. In a tropics where water is often a limiting factor, the inducement of plants to drought tolerance with CCC could be very important. Irrigation is a costly agricultural input, so its judicious application is necessary. Deficit water application could help not only in reducing production costs, but also in conserving water and minimizing leaching of nutrients and pesticides into ground water. With this in view, it was necessary to study the response of tomato plants to both quantitative and temporal variation in soil moisture. By restricting moisture at a non-susceptible phonological stage it may be possible to reduce irrigation water quantity and increase water-use efficiency. In crops, water stress has been associated with reduced yields and possible crop failure. The effects of water stress however vary between plant species. As the plant undergoes water stress, the water pressure inside the leaves decreases and the plant wilts. The main consequence of moisture stress is decreased growth and development caused by reduced photosynthesis, a process in which plants combine water, carbon dioxide and light to make carbohydrates for energy. Chemical limitation is crucial to maintaining the growth of plants; the most common symptom is wilting (Kamrun, 2011). Considering the above fact the present study was undertaken to determine the effect of chlorocholine chloride on growth, morpho-physiology and yield of tomato at different moisture levels.

Materials and Methods

Study area

The research work was conducted at Horticulture Farm in Sher-e-Bangla Agricultural University

(SAU), Dhaka, Bangladesh. The experiment was carried out during Rabi season (November, 2014 to March, 2015). It was located in 24.09° N latitude and 90.26° E longitudes. The altitude of the location was 8 m high from the sea level (The Meteorological Department of Bangladesh, Agargoan, Dhaka).

Soil and plant properties

The land belongs to the Agro-ecological zone "Madhupur tract" (AEZ-28) having the red brown traces soils and acid basin clay of Nodda soil series A high yielding tomato variety (BARI Tomato 14) was used as experimental material in the research work.

Experiment and treatment

The experiment consisted of two factors: Factor A: three levels of CCC, i. I_0: 100% ET (Evapotranspiration) moisture ii.I_2 = 80% ET moisture iii.I_3 = 60% ET moisture. Factor B: Chlorochorine chloride (CCC) i. F_0: Foliar spray with water (control) ii. F_1: Foliar spray with 1000 ppm CCC iii.F_2: Foliar spray with 2000 ppm CCC. The experiment was laid out in a Completely Randomized Design (CRD) with three replications.

Soil was collected from a fertile land of SAU Horticulture farm and prepared it with recommended fertilizer dose treated with Sevin 50WP @ 5 kg/ha to protect the young plants from the attack of ants and cutworm. Plastic pots were used in this experiment. Gravimetric method was used to find out proper strategy to irrigate pot plants. Harvesting of fruits was started at 80 DAT and continued up to final harvest based on the marketable sized of fruits.

Data collection and analysis

The data were collected to assess plant growth, yield and yield attributes. The collected data from the experimental plot on morphology yield and yield contributing characters are compiled and analyzed using the Statistical, Mathematical Calculation and Data Management (MSTATC) package program. Morphological variation and yield performance among the treatments were studied by Analysis of Variance (ANOVA) by F-test by least significant difference (LSD) test at 5% and 1% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Plant height

Plant height of BARI tomato-14 varied significantly due to the application of different level of moisture (Fig.1). The highest plant height (32.56, 59.78 and 83.44 cm at 30, 60 and 90 DAT, respectively) was recorded from I_0 (100% ET moisture) followed by I_1 (80% ET moisture and the lowest plant height which was recorded from I_2 (60% ET moisture). In the experiment, moisture increased plant height. Similar result was observed by Altintas (2011).

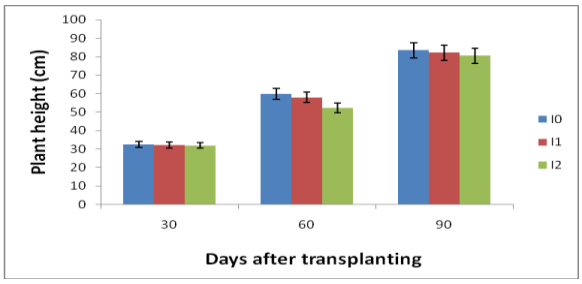

Fig. 1. Effect of ET moisture on plant height of tomato (Vertical bars indicate LSD value)

Significant variation was observed by the effect of CCC on plant height of tomato (Fig. 2). Foliar spray of water influenced for better growth than spray of CCC. The longest plant (33.00, 59.78 and 84.89 cm at 30, 60 and 90 DAT respectively) was recorded from F_0 (Foliar spray of water; control) which was statistically identical with F_1 (Foliar spray with 1000 ppm CCC) at 60 DAT.The lowest plant height (31.78, 50.56 and 80.22 cm at 30, 60 and 90 DAT respectively) was achieved from F_2 (Foliar spray with 2000 ppm CCC) where CCC influenced to reduce the plant height. Similar result was also found by Rudich and Luchinsky (1987) and Ghuman and Lai (1983).

The interaction effect of moisture and CCC showed significant variation on plant height. The findings showed the variation among all treatments. The highest plant height (34.00, 61.67 and 91.00 cm at 30, 60 and 90 DAT respectively) was recorded from I_0F_0 which was statistically similar with I_1F_1 and I_2F_1 at 30 DAT where the lowest plant height (31.33, 34.00 and 81.00 cm at 30, 60 and 90 DAT respectively) was achieved from I_2F_2

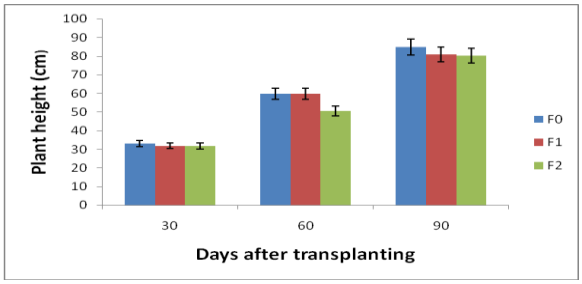

Fig. 2. Effect of CCC on plant height of tomato (Vertical bars indicate LSD value)

Table 1. Effect of ET moisture & CCC on plant height of tomato at different days after transplanting

Treatments	Plant height (cm)		
	30 DAT	60 DAT	90 DAT
I_0F_0	34.00 a	61.67 a	91.00 a
I_0F_1	32.33 ab	57.67 d	74.00 g
I_0F_2	31.67 b	61.67 a	81.33 e
I_1F_0	31.67 b	61.00 b	85.00 b
I_1F_1	32.33 ab	56.00 e	82.67 d

I_1F_2	32.00 b	60.00 c	82.67 d
I_2F_0	32.00 b	58.00 d	76.33 f
I_2F_1	32.67 ab	60.00 c	84.00 c
I_2F_2	31.33 b	34.00 f	81.00 e
$LSD_{0.05}$	1.777	0.6070	0.6070
CV (%)	8.359	7.468	9.274

(Means bearing same letters do not differ significantly at 5% level of significance)

Foliage coverage

The results of foliage coverage showed significant variation on plant height of tomato for different level of Moisture (Fig. 3). The highest foliage coverage (52.83, 77.00 and 88.89 at 30, 60 and 90 DAT respectively) was recorded from I_1 (80% ET moisture) which was statistically similar with I_0 at 30 DAT and the lowest foliage coverage (50.78, 74.11 and 77.78 cm at 30, 60 and 90 DAT) was recorded from I_2 (60% ET moisture) followed by I_0 (100% ET moisture) at 60 and 90 DAT respectively. This result might be due to cause of proper moisture level. Similar result was found by Westerfield (2005).

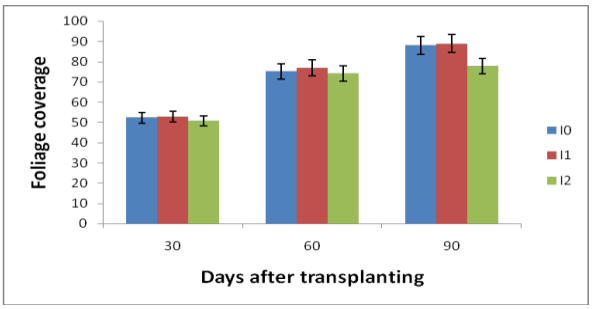

Fig. 3. Effect of ET moisture on foliage coverage of tomato (Vertical bars indicate LSD value)

Effect of CCC on foliage coverage of tomato showed the significant variation (Fig.4). Foliar spray was better than control stage of application of CCC. The increasing rate of foliage coverage was high in control level of CCC influenced for better growth than spray of CCC. The maximum foliage coverage (53.00, 76.67 and 89.78 cm at 30, 60 and 90 DAT, respectively) was recorded from F_1 (Foliar spray with 1000 ppm CCC) followed by F_2 (Foliar spray with 2000 ppm CCC) where the minimum foliage coverage (51.44, 73.67 and 76.56 cm at 30, 60 and 90 DAT) was achieved F_0 (Foliar spray of water; control). The result obtained from the present findings was conformity with the findings of Dhanasekaran *et al*., (2005).

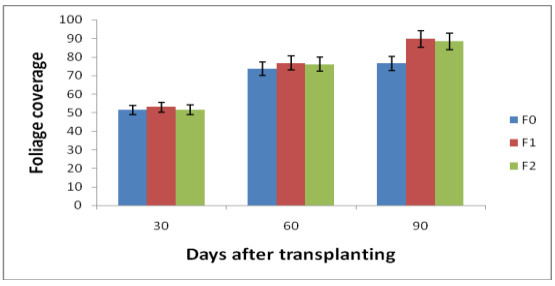

Fig. 4. Effect of CCC on foliage coverage of tomato (Vertical bars indicate LSD value).

Significant variation was found in the interaction effect of moisture and CCC on foliage coverage of tomato. The studied findings showed the highly variation among all treatments (Table 2). The maximum foliage coverage (55.00, 79.33 and 93.00 cm at 30, 60 and 90 DAT respectively) was recorded from I_1F_1 followed by I_0F_1 at 30 DAT, I_1F_2 at 60 DAT and I0F0 at 90 DAT where the minimum foliage coverage (50.00, 72.67 and 53.67 cm at 30, 60 and 90 DAT respectively) was achieved from I_2F_0 followed by I_2F_1 and I0F0 at 30 DAT, I_0F_2 at 60 and 90 DAT.

Table 2. Effect of CCC on foliage coverage of tomato at different moisture levels

Treatments	Foliage coverage		
	30 DAT	60 DAT	90 DAT
I_0F_0	51.00 e	75.33 d	92.33 b
I_0F_1	54.00 b	73.00 f	86.00 f
I_0F_2	52.00 cd	74.00 e	87.67 e
I_1F_0	52.50 c	73.00 f	83.00 g
I_1F_1	55.00 a	79.33 a	93.00 a
I_1F_2	51.00 e	78.67 b	88.67 d
I_2F_0	50.00 f	72.67 f	53.67 h
I_2F_1	51.00 e	77.67 c	91.00 c
I_2F_2	51.33 de	75.33 d	88.67 d
$LSD_{0.05}$	0.7988	0.6095	0.6144
CV (%)	9.356	7.563	8.269

Number of leaves per plant

Significant variation was found on number of leaves plant-1 of tomato at different level of moisture (Fig.5). The highest number of leaves plant-1 (10.78, 19.11 and 27.33 cm at 30, 60 and 90 DAT respectively) was recorded from I_1 (80% ET moisture) which was statistically similar with I0 at 90 DAT and followed by I_0 (100% ET moisture) at 30 and 60 DAT. The lowest number of leaves plant-1(9.89, 17.33 and 24.33 cm at 30, 60 and 90 DAT) was recorded from I_2 (60% ET moisture). The result obtained from Westerfield (2005) was similar with the findings of the present study.

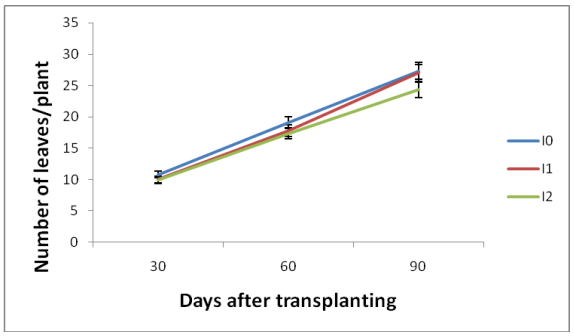

Fig. 5. Effect of ET moisture on number of leaves plant-1 of tomato (Vertical bars indicate LSD value)

The findings showed the significant effect of CCC on number of leaves plant-1of tomato (Fig. 6).The maximum foliage coverage (10.67 and 19.00 28.44 cm at 30, 60 and 90 DAT respectively) was recorded from F_2 (Foliar spray with 2000 ppm CCC)

which statistically same with F_1 (Foliar spray with 1000 ppm CCC) at 30 DAT, statistically similar at 60 DAT and followed by F1 (Foliar spray with 1000 ppm CCC) at 90 DAT where the minimum foliage coverage (9.67, 16.56 and 23.56 cm at 30, 60 and 90 DAT) was achieved from F_0 (Foliar spray of water; control). The result was in agreement with the study of Gupta et al., (2001).

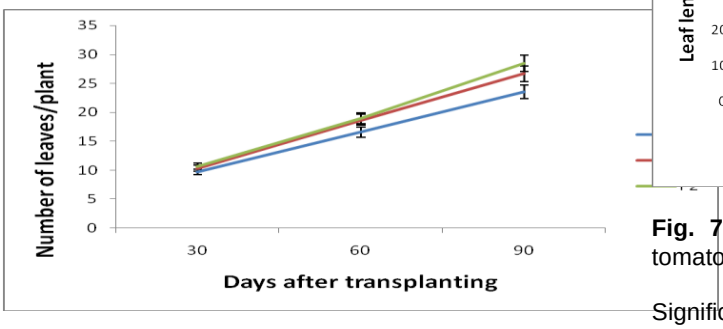

Fig. 6. Effect of CCC on number of leaves plant^{-1} of tomato(Vertical bars indicate LSD value)
F_0= Foliar spray of water (control), F_1= Foliar spray with 1000 ppm CCC, F_2 = Foliar spray with 2000 ppm CCC

Significant variation was found in the interaction effect of moisture and CCC on number of leaves plant-1 of tomato. The findings showed the significant variation among all treatments (Table 3). The maximum number of leaves plant-1 (11.00, 21.33 and 32.00 cm at 30, 60 and 90 DAT respectively) was recorded from I_0F_2 which was followed by I_0F_1 at 60 and 90 DAT,where the minimum number of leaves plant-1 (9.33, 15.00 and 22.67 cm at 30, 60 and 90 DAT respectively) was achieved from I_2F_0.

Table 3. Effect of CCC on foliage coverage of tomato at different moisture levels

Treatments	Number of leaves plant^{-1}		
	30 DAT	60 DAT	90 DAT
I_0F_0	9.33 e	17.67 f	24.00 e
I_0F_1	10.33 c	19.67 b	30.00 b
I_0F_2	11.00 a	21.33 a	32.00 a
I_1F_0	10.33 c	17.00 g	24.00 e
I_1F_1	11.00 a	16.67 h	25.00 d
I_1F_2	10.33 c	18.33 d	28.00 c
I_2F_0	9.33 e	15.00 i	22.67 f
I_2F_1	9.67 d	18.00 e	25.00 d
I_2F_2	10.67 b	19.00 c	25.33 d
$LSD_{0.05}$	0.1935	0.1935	0.5528
CV (%)	8.39	6.472	9.271

Means bearing same letters do not differ significantly at 5% level of significance)

Leaf length (cm)

The findings showed the significant variation on leaf length (cm) of tomato for different level of moisture (Fig.7). The highest leaf length (36.44, 45.11 and 47.45 cm at 30, 60 and 90 DAT respectively) was recorded from I0 (100% ET moisture) followed by I_1 (60% ET moisture). The lowest leaf length (cm) (35.29, 43.94 and 46.94 cm at 30, 60 and 90 DAT) was recorded from I_2 (60% ET moisture). The findings from the present study was similar with the findings of Pugalia *et al*., (1992).

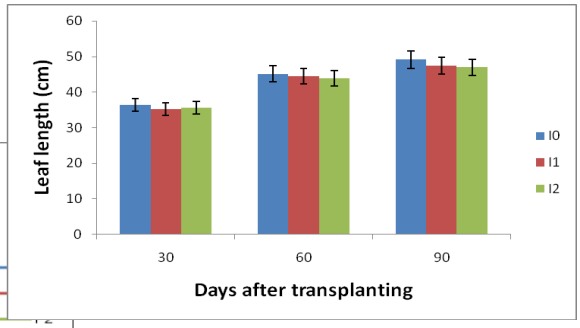

Fig. 7. Effect of ET moisture on leaf length of tomato (Vertical bars indicate LSD value)

Significant variation was observed on leaf length due to the application of CCC (Fig.8). The highest leaf length (28.83, 39.00 and 47.00 cm at 30, 60 and 90 DAT respectively) was recorded from F1 (Foliar spray with 1000 ppm CCC) which was followed by F_2 (Foliar spray with 2000 ppm CCC) at 30 DAT, statistically same with F_2 (Foliar spray with 2000 ppm CCC) at 60 DAT while the minimum foliage coverage (26.06, 33.33 and 43.17 cm at 30, 60 and 90 DAT) was achieved from F_0 (Foliar spray of water; control). Similar was also found by Singh et al., (2002) and Sun et al. (2000).

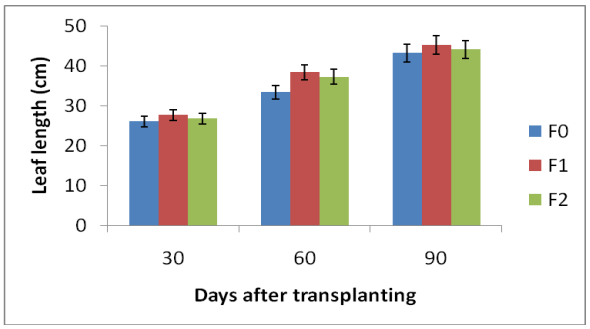

Fig. 8. Effect of CCC on leaf length of tomato (Vertical bars indicate LSD value)

Significant variation was found in the interaction effect of moisture and CCCon leaf length (cm) of tomato (Fig.8). The highest leaf length (28.83, 39.00 and 47.00 cm at 30, 60 and 90 DAT respectively) was recorded from I_0F_1 whereas the lowest leaf length of tomato (26.00, 34.00 and 43.67cm at 30, 60 and 90 DAT, respectively) was found from I_0F_0 .

Table 4. Effect of CCC on foliage coverage of tomato at different moisture levels

Treatments	Leaf length (cm)		
	30 DAT	60 DAT	90 DAT
I_0F_0	26.00 f	34.00 g	43.67 g
I_0F_1	28.83 a	39.00 a	47.00 a
I_0F_2	26.67 d	37.00 e	44.67 e
I_1F_0	27.50 bc	34.00 g	44.33 f

I_1F_1	27.67 b	37.67 d	46.33 b
I_1F_2	27.33 c	36.00 f	44.17 f
I_2F_0	24.67 g	32.00 h	42.67 h
I_2F_1	26.33 e	38.33 c	45.67 c
I_2F_2	26.17 ef	38.67 b	45.00 d
$LSD_{0.05}$	0.2162	0.2681	0.2737
CV (%)	8.563	10.294	7.527

(Means bearing same letters do not differ significantly at 5% level of significance)

Lengths of internodes (cm)

Significant variation was found on length of internodes (cm) of tomato for different level of moisture at 60 and 90 DAT (Fig. 9). The highest length of internodes 8.11 cm was recorded from I_1 (80% ET moisture) which was statistically similar with I_0 (100% ET moisture) at 90 DAT while the lowest length of internodes 7.88 cm at 90 DAT was recorded from I_2 (60% ET moisture)

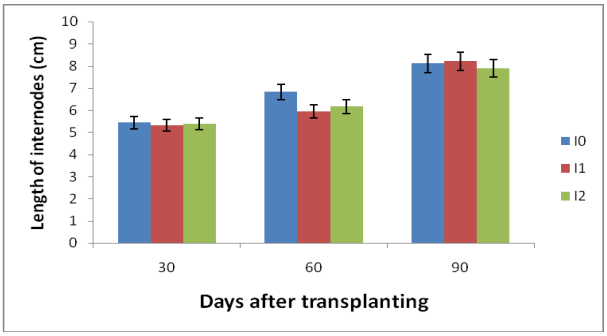

Fig. 9. Effect of ET moisture on length of internodes of tomato (Vertical bars indicate LSD value)

Non-significant variation was found due to the effect of CCC on length of internodesof tomato (Fig. 10).It was observed that the highest internodal length (5.50, 6.16 and 7.13 cm at 30, 60 and 90 DAT, respectively) was found from F_0 where the lowest (5.27, 4.76 and 4.40 at 30, 60 and 90 DAT respectively) was obtained from F_2.

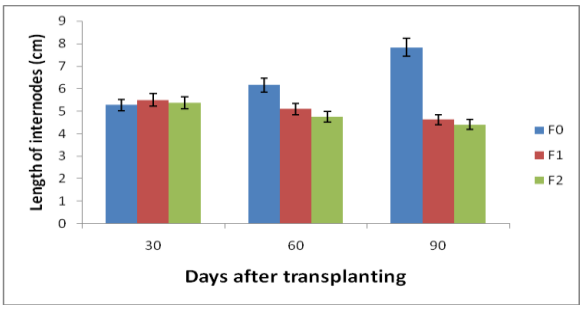

Fig. 10. Effect of CCC on length of internodes of tomato (Vertical bars indicate LSD value).

Significant variation was found due to the interaction effect of moisture and CCC on length of internodes of tomato at 60 and 90 DAT (Table 5). The highest length of internodes (6.83 and 8.50 cm at 60 and 90 DAT, respectively) was recorded from I_0F_0 followed by I_2F_0 at 60 and I_1F_0 90 DAT, respectively but at 30 DAT there was no significant effect of the treatment combinations. The lowest length of internodes (4.94 and 4.67 cm at 60 and 90 DAT respectively) was recorded from I_2F_2.

Table 5. Effect of CCC on Length of internodes of tomato at different moisture levels

Treatments	Length of internodes (cm)		
	30 DAT	60 DAT	90 DAT
I_0F_0	5.33	6.83 a	8.50 a
I_0F_1	5.50	5.33 d	5.00 d
I_0F_2	5.50	5.13 f	4.90 e
I_1F_0	5.00	5.50 c	7.83 b
I_1F_1	5.50	5.30 d	4.86 e
I_1F_2	5.50	5.00 g	4.75 g
I_2F_0	5.16	5.66 b	7.16 c
I_2F_1	5.50	5.20 e	4.76 f
I_2F_2	5.50	4.94 g	4.67 h
$LSD_{0.05}$	NS	0.078	0.052
CV (%)	3.625	7.542	10.236

(Means bearing same letters do not differ significantly at 5% level of significance)

Number of fruits cluster-1:

Different level of moisture showed significant effect on number of fruits cluster-1 of tomato at different days after transplanting (DAT). The highest number of fruits cluster-1 was found from I_0 (100% ET moisture) which was statistically identical with I1 (80% ET moisture) at the same time where the lowest number of fruits cluster-1 was achieved from I_2 (Table-6).

Number of fruits sets plant-1:

Different levels of moisture had significant effect on number of fruits sets plant-1 of tomato at different days after transplanting. The highest number of fruits sets plant-1 was found from I_0 (100% ET moisture) where the lowest number of fruits sets plant-1 was achieved from I_2 (60% ET moisture).Different levels of CCChad significant effect on number of fruits sets plant-1 of tomato at different days after transplanting (Table 6) . Results indicated that the highest number of fruits sets plant-1 was found from F_1 (Foliar spray with 1000 ppm CCC) followed by F_2 (Foliar spray with 2000 ppm CCC) where the lowest number of fruits sets plant-1 was achieved from F_0.

Table 6. Main effect of different moisture level and CCC on yield contributing characters of tomato

Treatments	Number of fruits cluster^{-1}	Number of fruits sets plant^{-1}	Relative water content (%)	Chlorophyll Content (µmol m^{-2})	CO_2assimilation/ Photosynthesis rate (µmol m-2 s^{-1})	Fruit length (cm)	Fruit diameter (cm)	Total weight of fruit plant^{-1} (kg)	Total number of fruits plant^{-1}
Effect of Moisture									
I_0	10.67 a	20.00 a	6.28 a	46.26 c	7.83 a	6.05 a	6.42 b	1.11 b	32.22 a
I_1	10.44 a	17.22 b	5.28 c	47.72 a	5.37 c	6.11 a	6.82 a	1.23 a	27.67 b
I_2	9.11 b	16.33 c	5.74 b	47.27 b	5.84 b	4.60 b	5.47 c	1.02 b	26.00 c
$LSD_{0.05}$	0.4844	0.1117	0.1593	0.1580	0.3589	0.1516	0.1548	0.1048	0.3547
CV (%)	9.346	9.267	4.361	3.697	4.249	8.369	6.592	5.389	9.621
Effect of CCC									
F_0	9.44 c	16.22 b	6.36 a	47.59 a	7.03 a	4.93 b	5.76 c	1.14 ab	26.11 b
F_1	10.33 b	19.11 a	6.03 b	46.67 b	5.92 c	6.40 a	6.73 a	1.48 a	28.67 a
F_2	10.44 a	18.22 a	4.91 c	46.99 b	6.09 b	5.70 ab	6.22 b	1.04 b	29.11 a
$LSD_{0.05}$	0.094	1.012	0.150	0.3533	0.1108	1.284	0.3589	0.1095	0.5036
CV (%)	9.346	9.267	4.361	3.697	4.249	8.369	6.592	5.389	9.621

Means bearing same letters do not differ significantly at 5% level of significance

Relative water content (%):

Significant influence was found for different levels of moisture on relative water content of tomato the highest relative water content (6.28) was found from I_0 (100% ET moisture) which was significantly different from other treatments where the lowest relative water content(5.28) was achieved from I_1 (80% ET moisture) followed by I_2 (60% ET moisture) (Table 6)..

Chlorophyll Content (µmol m-2):

Chlorophyll Content of the plant significantly influenced by different levels of moisture). The highest chlorophyll Content (47.72) was found from I_1 (80% ET moisture) which was significantly different from other treatments where the lowest chlorophyll content (46.26) was achieved from I_0 (100% ET moisture) and intermediate result was found from I_2 (80% ET moisture) (Table 6). Different levels of CCC had significant effect on chlorophyll Content of tomato. The highest chlorophyll Content (47.59) was found from F_0 (Foliar spray of water; control) which was statistically different from others where the lowest chlorophyll Content (46.67) was achieved from F_1 (Foliar spray with 1000 ppm CCC) which was statistically identical with F_2 (Foliar spray with 2000 ppm CCC).Chlorophyll content of tomato significantly varied due to the interaction effect of moisture and CCC. The maximum chlorophyll content (50.03) was found from I_2F_1 followed by I_0F_0 and I_1F_0 (Table-7). Again, the lowest stomata Conductance (0.04) was found from I_0F_1.

Table 7. Combined effect of different moisture level and CCC on morpho-physiological properties of tomato

Treatment	Number of fruits cluster^{-1}	Number of fruits sets plant^{-1}	Relative water content (%)	Chlorophyll Content (µmol m-2)	CO_2 assimilation/ photosynthesis rate (µmol m-2 s-1)
I_0F_0	10.00 d	18.00 b-d	7.83 a	48.77 b	7.21 a-c
I_0F_1	10.67 b	23.67 a	5.99 c	42.80 f	8.28 a
I_0F_2	11.33 a	18.33 bc	5.01 e	47.20 c	8.00 ab
I_1F_0	10.33 c	16.33 de	5.12 e	48.53 b	6.87 a-c
I_1F_1	10.67 b	15.67 ef	5.62 d	47.17 c	3.20 d
I_1F_2	10.33 c	19.67 b	5.10 e	47.47 c	6.03 c
I_2F_0	8.00 f	14.33 f	6.14 b	45.47 e	7.00 a-c
I_2F_1	9.66 e	18.00 b-d	6.48 b	50.03 a	6.27 bc
I_2F_2	9.66 e	16.67 c-e	4.62 f	46.30 d	4.25 d
$LSD_{0.05}$	0.2106	1.752	0.1935	0.6120	1.751
CV (%)	9.346	9.267	4.361	3.697	4.249

(Means bearing same letters do not differ significantly at 5% level of significance)

Table 8
Combined effect of different moisture level and CCC on different yield and yield contributing parameters of tomato.

Treatments	Fruit length (cm)	Fruit diameter (cm)	Total number of fruits plant^{-1}	Total weight of fruit plant^{-1} (kg)
I_0F_0	5.04 a-c	5.55 e	29.67 bc	1.09 ab
I_0F_1	6.67 a	6.93 b	30.67 b	1.09 ab
I_0F_2	6.44 ab	6.77 b	36.33 a	1.13 ab
I_1F_0	5.45 a-c	6.81 b	30.33 b	1.24 ab
I_1F_1	6.81 a	7.21 a	26.33 c	1.27 a
I_1F_2	6.12 ab	6.45 c	26.33 c	1.18 ab
I_2F_0	4.32 c	4.93 f	24.33 d	1.05 b
I_2F_1	5.73 a-c	6.05 d	29.00 bc	1.20 ab
I_2F_2	4.52 bc	5.44 e	24.67 cd	0.82 c
$LSD_{0.05}$	1.741	0.273	1.752	0.1935
CV (%)	8.369	6.592	9.621	5.389

(Means bearing same letters do not differ significantly at 5% level of significance)

CO2 assimilation/photosynthesis rate (µmol m-2 s-1):

Data presented in Tables explained that CO_2 assimilation/photosynthesis rate of the plant significantly influenced by different levels of moisture. The highest CO_2 assimilation/ photosynthesis rate (8.28) was found from I_0 (100% ET moisture) which was significantly different from other treatments where the lowest CO_2 assimilation/photosynthesis rate (0.20) was achieved from I_1 (80% ET moisture) and intermediate result was found from I_2 (80% ET moisture) (Table 7).

Conclusion

Considering the findings of experiment, application of CCC were found to contribute positively almost all parameters in plants subjected to mild moisture stress, where at higher moisture stress with 1000 ppm CCC were not afforded to express suitable physiological performance. Under the present study, 80% ET moisture performed better for growth and yield parameters compared to lower water level. The combined effect I_1F_1 performed better on growth, yield and yield attributes of tomato than other treatment combination.

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