INFLUENCE OF ANTI-TRANSPIRANT AND CCC ON GROWTH AND FLOWERING OF TUBEROSE AT DIFFERENT MOISTURE REGIMES

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BY

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ABSTRACT

A pot experiment was carried out at Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka during the period from May 2013 to November 2013.The experiment consisted of two factors: Factor A: Different moisture regime; I_0 (100% control), I_1 (75%), I_2=(50%) ET irrigation respectively and ; Factor B: Foliar application of anti-transpirantwith CCC; F_0 = Foliar spray with water (control), F_1= Foliar spray with 3% Kaolin, F_2 = Foliar spray with 1000ppm CCC, F_3=Foliar spray with 3% Kaolin and 1000ppm CCC. The two factor experiment was laid out in Randomized Complete Block Design with three replications. Application of Kaolin and CCC with different irrigation level showed significant variations on most of the parameters.In case of Kaolin and CCC; the highest spikelet per spike 50.02 was recorded from F_3,the highest length of flowering stalk 91.00 cm from F_0, the highest length of rachis 31.80 cm from F_0, the highest weight of bulb 152.70 g from F_3. In case of moisture regime the highest spikelet per spike 52.50 was found from I_0, the maximum length of flowering stalk 94.65 cm from I_0, the maximum length of rachis 31.27 cmI_0. For combined effect,the highest spikelet per spike 60.00 from I_0F_3,the maximum length of flowering stalk 103.00 cm from $I_0F_0$the maximum length of rachis 38.70 cm from I_0F_0, the maximum weight of bulb 43.70 g from in I_1F_3.So, 75% ET irrigation and 3% foliar spray of Kaolin with 1000 ppm CCC showed better performance for growth and flowering of tuberose.

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CHAPTER I

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) cv. double is valuable flower that bloom during summer season. It is native to Mexico and belongs to family Amarylladaceae. It produces conspicuous and showy cut flower that are important commercially and aesthetically. Its cultivation in Bangladesh is gaining popularity due to ease of cultivation, low input, wide adaptability, multipurpose use and higher return. The lingering delightful fragrance, excellent keeping quality and easy cultivation are the predominant characteristics of this crop. Tuberose flowers are in great demand as cut flowers, preparation of most artistic garlands, floral ornaments, bouquets, button holes and for their essential oil. The long spikes are excellent for table decoration. The tuberose flowers are durable although brittle and remain fresh for pretty long time and stand long distance transportation due to their waxy nature. It is getting more importance among growers and floriculturists due to its production in summer and autumn season due to the unavailability of other ornamental flower bulbs during this period.

There is a critical balance between water requirement and water consumption of the crops. Thus, conserving water is an important aspect for agricultural expansion particularly in arid and semiarid regions where water deficit and high temperature are the main limiting factors for plant growth and productivity (Taiz and Zeiger 2002). At present and most probably also in the future, as a result of global warming, irrigated agriculture will take place under water scarcity. In other words, irrigation management in arid and semi-arid regions will shift from emphasizing production per unit area towards maximizing the production per unit of water consumed (Fereres and Soriano, 2007). Due to the important and precious values of water in recent years and in the same time the need for using such valuable plant, much more attention must be given to study the growth and productivity within appropriate water consumption. (Halepyati *et al*. 1996) on tuberose plants found that transpiration rate was increased with increasing irrigation levels. Water deficit often causes reduction in plant growth by inhibiting leaf and stem elongation (Younis *et. al.*, 2000) and by reducing nutrient uptake by plants. In addition, water deficit affects negatively the process of flowering in many plant species by reducing the fertility of newly formed flowers (Slawinska *et. al.*, 2001). Under such drought conditions, actively growing plants transpire a weight of water equal to their leaf fresh weight each hour if water is adequately supplied (Moftah, 1997). Thus, it is necessary to find ways by which available water could be economically utilized. One way to achieve this goal is by reducing the transpiration rate using anti-transpirants to minimize the amount of applied water.

Antitranspirants were grouped into three categories, namely film-forming types (which coat leaf surface with films that are impervious to water vapor), reflecting materials (which reflect back a portion of the incident radiation falling on the upper surface of the leaves) and stomatal closing types (which affect the metabolic processes in leaf tissues. Antitranspirants are chemical compounds applied to regulate the transpiration of plants and maintain a favorable plant water status (Song *et al*., 2011). Kaolin is a non-abrasive, non-toxic aluminosilicate clay mineral that has been formulated as a wet table powder for application with conventional spray equipment. Use of Kaolin increase efficiency and photosynthetic activity of plants under drought condition (Moftah and Al-Humaid, 2005). Foliar applications of kaolin particle films reduce plant stress, which is important for optimum plant growth, yield and quality (Cantore *et al*., 2009). Kaolin cools tissues and protects plants from extreme heat and ultraviolet radiation by increasing leaf reflectance and reducing transpiration rate (Glenn *et al.* 2010). Early studies demonstrated that Kaolin improved the water status and the growth of water-stressed tuberose plants (Glenn *et. al*., 2003).

Application of growth retardent such as cycocel (CCC) at certain doses had an effective role on the growth, flowering and bulb productivity of many flowering bulbs. Growth retardants CCC (2-chloroethyl trimethyl ammonium chloride) markedly reduced stem length, number of leaves / plant of ornamental plants. It is found that CCC at 1000 ppm increased chlorophyll a, b and carotenoides contents of leaves (Hassanein and Manoly, 2004).

However, the present study was undertaken with the following objectives:

1. To know the performance of tuberose under anti-transpirant and growth retardant treatment.

2. To know the performance of tuberose under different moisture regime.

3. To determine the effect of kaolin and CCC on the flowering and yield of tuberose under different moisture conditions.

CHAPTER II

REVIEW OF LITERATURE

Tuberose *(Polianthes tuberosa)* is one of the popular and commercially important bulbous flower crops and occupies a prime position in our domestic market. It is a multipurpose flower, which has a great demand as a cut flower, loose flower and for its aromatic value. The tuberose farmers lack improved technology regarding increasing yield. Many research works have been done on various aspects of this cut flower in Bangladesh. However, a limited research related to tuberose cultivation emphasising on anti-transpirants, growth retardants and water stress have been carried out in Bangladesh. Nevertheless, some of the important and informative works regarding anti-transpirants, growth retardants and water stress so far been done at home and abroad of this plant have been reviewed below under the following headings:

2.1 Review in Relation to the effect of anti-transpirants:

Mina *et al*. (2013) evaluated the effect of some anti-transpirants on plant traits, yield and yield components in soybean (*Glycine max*) under limited irrigation. They conducted an experiment in the research field of Urmia University in 2010. The experiment was arranged in a complete randomized block design with four replications. Antitranspirants consist of Kaolin (6%), Chitosan (0.1%), castor bean oil (1%), magnetic water and control (without antitranspirant). These materials applied 60 days after planting (flowering stage) and in seed formation stage. After spraying the plants with antitranspirants, irrigation in these stages were interrupted in all plots and irrigation intervals increased from 10 days to 20days. They found that the application of antitranspirants significantly increased stem height, node number, stem diameter, number of pods and number of seeds per plant, thousand seed weight, seed yield, biological yield and harvest index in treated plants but the number of seeds per pod were not affected by these antitranspirants. Among the materials used kaolin had the most influence on seed yield thus seed yield increased 23/85% compared to control. Findings of this experiment suggest that using antitranspirants can be effective by reducing the effect of water stress in soybean yield.

Yuly *et al., (*2011) carried out a field experiment to know the effect of kaolin film particle application and water deficit on physiological characteristics in rose plants. They have studied foliar applications of a kaolin clay particle film on leaf temperature, chlorophyll content, shoot length, production and water relations in well-irrigated and water-stressed rose plants (Rose spp.) during ten weeks. Plants were sprayed twice at first and fifth week after the experiment started with aqueous suspensions of kaolin (Surround) at a dose of 5% (w/v). The interaction between kaolin applications and water status did not show significant responses. Water stress decreased the stomatal conductance, leaf water content (LWC), shoot length and the number of marketable floral stems. Kaolin sprays did not affect on SPAD readings, chlorophyll, fluorescence, stomatal conductance, LWC and shoot length. Kaolin reduced leaf temperature by 2.5^{0}C approximately at midday compared to plants non-sprayed with kaolin. These results show that kaolin foliar applications could be considered a useful tool at early growth stage in improving rose plants acclimation to high temperature level under greenhouse conditions in tropical region.

Cantore *et al*., (2009) investigated the underlying mechanism asserted by kaolin on tomato physiology by evaluating its effect on leaf, canopy and inner fruit temperatures, gas exchange at the leaf and canopy scales, above ground biomass, yield and fruit quality. Stomatal conductance decreased by 53% in treated plants, resulting in reductions of 34% and 15% in transpiration and internal CO_2 concentration, respectively. Marketable yield in kaolin-treated plants was 21% higher than those measured in control plants; this is possibly related to the reduction in sunburned fruit and those damaged by insects, respectively, and to the 9% increase in mean fruit weight, Kaolin treatment increased lycopene fruit content by 16%.

Ibrahim and Selim (2007) conducted a field experiment at a private farm near Mansoura city, Dakahlia Governorate, Egypt during two summer seasons (2008-2009) to study the effect of irrigation intervals and antitranspirant (Kaolin) on summer squash (*Cucurbita* *pepo* L.) growth, yield, quality and economics. They exposed the plant at three irrigation intervals (8, 12 and 16 days, from first irrigation) and spraying kaolin at (0.3 and 0.6%) as antitranspirants at 25, 40 and 55 days from planting and their interactions on growth, yield, fruit quality and water use efficiency of summer squash cv. Eskandrani. Result indicated that irrigation every 8 days throughout growing season resulted in highest foliage weight, leaf weight per plant, mean fruit weight, total fruit yield/fed, marketable yield/fed and seasonal applied water in both summer seasons. On the contrary, increasing irrigation intervals from 8 up to 16 days caused significant increases in leaves dry matter percentage, total soluble solids and dry matter percentage in fruit and water use efficiency in both seasons. On the other hand, all studied characters except leaves dry matter percentage, dry matter percentage in fruit and seasonal applied water were significantly increased with increasing kaolin levels in both seasons. The interaction effect between irrigation intervals and kaolin levels were significant for all the studied parameters in both seasons. The highest net return was observed with plants watered every 8 days and received kaolin at 6% concentration followed by watered every 12 days and received kaolin at 6% concentration that had higher benefit: cost ratio. From the economic and nutritional point of view, it could be concluded that irrigation every 12 days interval combined with spraying kaolin at 6% concentration to summer squash cv. Eskandrani might gave the chance for increasing water use efficiency and produce satisfactory and good marketable fruit yield under similar conditions of this work.

Moftah and Al-Humaid, (2005) in study of the effect of kaolin and Vaporgard on the photosynthesis and water relations of potato plants concluded that by the use of both antitranspirants efficiency and photosynthetic activities increased in plants under drought stress .Their results showed that water use efficiency (WUE) in plants treated with kaolin were significantly higher than plants treated with Vaporgard.

2.2 Review in Relation to the Effect of Growth Retardant:

Ramesh Kumar *et al*. (2013) carried out a study to evaluate the effect of plant growth regulators on growth, flowering and bulb production of tulip under Karewa conditions of

Kashmir Himalaya during 2009 to 2011. The three different growth regulators; gibberellic acid (GA_3) at 100, 200, and 400 ppm, 2-chloroethyl trimethyl ammonium chloride (CCC) and maleic hydrazide (MH) each at 100, 200 and 500 ppm along with control were applied as dip treatment and foliar spray. Plant height was recorded maximum with 400 ppm GA_3 (37.32 cm) followed by 200 ppm GA_3 (34.13 cm). GA_3 at 400 ppm significantly caused earliest flowering (141.30 days) followed by 200 ppm GA_3 (142.43 days) as compared to the control (148.93 days), while delayed flowering were observed by 500 ppm MH (152.96 days) followed by 200 ppm MH (151.93 days). The longest blooming period was recorded in 200 ppm GA_3 (28.46 days) followed by 400 ppm GA_3 (27.76 days) in comparison to the control (21.59 days). The maximum vase life was obtained with 400 ppm GA_3 (11.26 days) followed by 200 ppm GA_3 (10.43 days) over the control (7.30 days). The maximum number of bulbs and daughter bulbs per plant were recorded with 400 ppm GA_3 (1.43 and 3.03) followed by 500 ppm CCC (1.41 and 2.65) over the control (1.07 and 1.72), respectively and thereby enhanced propagation coefficient was obtained in 400 ppm GA_3 (258.66%) followed by 500 ppm CCC (237.73%) as against the control (170.00%).

Ragaa (2012) carried out an investigation at the Nursery of Ornamental plants, Faculty of Agriculture, Minia University, Egypt during the two successive seasons of 2008 / 2009 and 2009 / 2010 to study the effect of different concentrations of gibberellins (GA), cycocel (CCC) and 3 Alar on the growth, flowering and bulb production of iris plants. In this study the the iris plants were sprayed three times with 0, 250, 500 and 750 ppm of GA_3, 250, 500 and 1000 ppm of CCC and 125, 250 and 500 ppm of Alar. Results showed that GA_3 treatments significantly increased leaf length, while, CCC and Alar treatments significantly decreased the leaf length compared to control treatment. GA_3 treatments shortened significantly the time taken from planting to flowering, while CCC and Alar treatments significantly delayed the flowering date compared to control. Also, the flowering stalk length was increased by application of GA_3 at the three used concentrations, while, CCC and Alar at the same concentrations led to decrease in the flowering stalk length. The positive or negative effects of GA_3 or CCC and Alar were gradually increased by increasing their concentrations. All treatments of GA_3, CCC and Alar led to increased flowering stalk diameter, fresh and dry weights of the flowering stalk and fresh weight of inflorescence / plant compared to control. The best results were obtained by using of high concentration of GA_3, CCC and Alar. All GA_3, CCC and Alar treatments had a stimulatory effect on the formation of new bulbs and bulblets compared to the control treatment. The highest of fresh weight of new bulbs and bulblets / plant and the highest number of bulblets / plant were obtained by the application of GA_3 at 750 ppm, CCC at 1000 ppm and Alar at 500 ppm. Total chlorophyll content of the leaves was increased as a result of using different concentrations of CCC or Alar. Meanwhile, total chlorophyll content was decreased by the application of the three used concentration of GA_3 compared to the control. The highest percentage of the total carbohydrates in the bulbs was obtained by the application of GA_3 at 750 ppm followed by CCC at 1000 and Alar at 500 ppm.

Sharifuzzaman *et al*. (2011) conducted an experiment to evaluate the three different concentrations of gibberellic acid (GA_3), cycocel (CCC) and maleic hydrazide (MH) on the vegetative growth, yield and quality of chrysanthemum. Four weeks old seedlings were transplanted in pot where aqueous solution containing 3 concentrations of GA_3 (50, 100, 150 ppm), CCC (400, 600, 800 ppm) and MH (250, 500, 750 ppm) were applied along with a carrier (control). GA_3 treated plants showed significant increase in plant spread, leave number and leave length. Irrespective of concentration, GA_3 also produced the higher number of sucker and flowers and CCC produced less. GA_3 also caused faster initiation of flowering and ACC and MH delayed it. Length of flower stalk significantly increased with GA_3. Use of CCC showed an increasing vase life of flowers. In this study, foliar application of 150 ppm GA_3 was the best for obtaining better growth of plants, maximum number of cut blooms with longer stalk as well as bigger flower size.

Lone *et al.,* (2010) studied that chlorocholine chloride (CCC) is a quaternary ammonium compound type of growth retardant involved in a diverse array of cellular, developmental and stress related processes in plants. A number of examples of the role played by CCC in the growth and development of plants were described, plant height, leaf number, leaf area index, dry mass, chlorophyll and photosynthetic parameters, photosynthetic active radiation, nutrient uptake, seed yield, biological yield, oil yield, harvest index, amino acid and protein content. The study indicates that the process of growth and development in addition to the yield of plants is significantly affected by the chlorocholine chloride in irrigated and non- irrigated conditions.

Ragaa (2012) carried out an investigation at the Nursery of Ornamental plants, Faculty of Agriculture, Minia University, Egypt during the two successive seasons of 2008 / 2009 and 2009 / 2010 to study the effect of different concentrations of gibberellins (GA), cycocel (CCC) and 3 Alar on the growth, flowering and bulb production of iris plants. In this study the the iris plants were sprayed three times with 0, 250, 500 and 750 ppm of GA_3, 250, 500 and 1000 ppm of CCC and 125, 250 and 500 ppm of Alar. Results showed that GA_3 treatments significantly increased leaf length, while, CCC and Alar treatments significantly decreased the leaf length compared to control treatment. GA_3 treatments shortened significantly the time taken from planting to flowering, while CCC and Alar treatments significantly delayed the flowering date compared to control. Also, the flowering stalk length was increased by application of GA_3 at the three used concentrations, while, CCC and Alar at the same concentrations led to decrease in the flowering stalk length. The positive or negative effects of GA_3 or CCC and Alar were gradually increased by increasing their concentrations. All treatments of GA_3, CCC and Alar led to increased flowering stalk diameter, fresh and dry weights of the flowering stalk and fresh weight of inflorescence / plant compared to control. The best results were obtained by using of high concentration of GA_3, CCC and Alar. All GA_3, CCC and Alar treatments had a stimulatory effect on the formation of new bulbs and bulblets compared to the control treatment. The highest of fresh weight of new bulbs and bulblets / plant and the highest number of bulblets / plant were obtained by the application of GA_3 at 750 ppm, CCC at 1000 ppm and Alar at 500 ppm. Total chlorophyll content of the leaves was increased as a result of using different concentrations of CCC or Alar. Meanwhile, total chlorophyll content was decreased by the application of the three used concentration of

GA_3 compared to the control. The highest percentage of the total carbohydrates in the bulbs was obtained by the application of GA_3 at 750 ppm followed by CCC at 1000 and Alar at 500 ppm.

2.3 Review Related to Water Stress:

Fetouh and Hassan (2014) studied the effect of irrigation intervals on the growth, flowering and chemical constituent of *Strelitzia reginae* Ait plant.They treated one year old plants with three different irrigation intervals at 10, 20 or 30 days. Irrigation water was added with constant level of 5 cm depth as (200 L/4m2). During a whole year of growing, Water consumptive use (CU), Crop coefficient (KC), Relative water content (RWC) and Water use efficiency (WUE) were calculated. The growth parameters and flowering characteristics as influenced by water regime were measured. Their study showed that, short irrigation interval enhanced vegetative growth as well as inflorescence yield compared to longer intervals. The chlorophyll content, N, P and K percentages in both leaves and inflorescences were gradually decreased with increasing irrigation intervals. The most significant irrigation interval was 10 days followed in most cases by 20 days interval treatment.

Shamim *et al.* (2014) examined eleven local/ exotic tomato genotypes thoroughly to estimate the reduction in crop growth and yield at different water regimes *i.e.*, at 80% of field capacity (optimum watered) 60% and 40% of field capacity (water deficit) conditions. Among all the genotypes, genotype *L. pennelli* out yielded followed by CLN1767 and *L. chilense* in terms of dry biomass and fruits as compared to rest of the genotypes. Lower water stress regimes (60 and 40% field capacities) further reduced significantly leaf area index. Whereas, CLN1767 and Lyallpur-1 were intermediate in total number of fruits. Lowest number of fruits but amazingly greater single fruit weight was recorded in Roma and Ratan at even 40% moisture regime. In view of these results, it could thus be concluded that considerable genetic variation exists in tomato and water stress tolerance that is associated with better adaption to water stress and can be used in breeding for stress tolerance.

Hassan and Ali (2013) studied the effect of five irrigation levels on growth, yield and chemical composition of coriander plants. The amount of irrigation water was equal to 40%, 60%, 80%, 100% and 120% of the potential evapotranspiration (ETP) values based on class-A pan. The irrigation water was applied by drip irrigation system. The results of this experiment showed that the vegetative growth parameters were improved as a result of applying higher irrigation levels compared to lower levels. Irrigation water use efficiency (IWUE) was increased by reducing the irrigation levels. Increasing the irrigation level from 40% to 120% increased the volatile oil percentage as well as fruit and volatile oil yields/hill and per fed. The results of GC analysis of volatile oil showed that the main components of volatile oil were linalool, ß-cymene, limonene, nerol, borneol and geraniol. However, the irrigation treatments did not affect oil composition. The chemical analysis of the coriander herb indicated that increasing the irrigation rate from 40% to 120% of ETP gradually decreased nitrogen, phosphorus and carbohydrate percentages in the dried herb of coriander plants. However, there was no clear trend for potassium percentage.

Abdel-Fattah (2013) conducted two pot experiments under full sun conditions at the Experimental Farm of Hort. Res. Inst., ARC, Giza, Egypt during 2010 and 2011 seasons to study the effects of spraying with aqueous solution of either calcium carbonate ($CaCO_3$) at 0, 6 and 9% or vapor gard, VG (96% di-l-p-Menthene) at 0, 2 and 3% concentrations, thrice with one month interval, on growth, flowering and chemical composition of 6-months-old transplants of China rose (*Hibiscus rosa-sinensis* L.) grown in 30cm diameter plastic pots filled with about 7kg of sand and clay mixture (1:1 v/v) under different water regimes (100, 80, 60 and 40% of water holding capacity (WHC). Their obtained results indicated that all vegetative and root growth parameters descendingly decreased with reducing the percent of WHC to reach the minimum values at 40% WHC treatment. The opposite was the right concerning the effect of antitranspirants which significantly improved all vegetative and root growth traits over control under the various water supply treatments, with the superiority of $CaCO_3$ at 6% treatment that gave the utmost high means in most cases of both seasons and followed by

VG at 3% treatment. So, the best vegetative and root growth was obtained from combining between irrigation at 100% WHC and spraying with either $CaCO_3$ solution at 6% or VG solution at 3% level. Irrigation treatment at 80% WHC caused a significant precocity in flowering in the first season. Number of flowers/plant was progressively decreased with the decrement of water supply, whereas $CaCO_3$ at 6% concentration significantly increased this trait. However, the interaction between 100% water supply and spraying with 6% $CaCO_3$ scored the highest No. flowers in the two seasons compared to control and other interactions. Contents of chlorophyll a, b, carotenoids, N, P, K, soluble and non-soluble sugars% and proline content in the leaves were gradually increased as the water supply was decreased. However, the best content of all previous constituents was recorded by $CaCO_3$ at 6% treatment. Hence, spraying with either $CaCO_3$ at 6% or VG at 3% solution, thrice with one month interval, may be recommended for overcoming the harmful effects on growth and performance of China rose (*Hibiscus rosa-sinensis* L.) transplants under water stress.

Metwally *et al.* (2013) studied the effects of water regime on the growth, content of essential oil and proline of *Calendula officinalis* L. plants. They observed that water regimes of 75% of field water capacity increased certain growth characters [i.e. plant height (cm), leaf area (cm_2), flower diameter (cm) and spike stem diameter] and vase life (day). Water regime promoted the accumulation of essential oil content and its main components as well as proline contents.

Nahar and Ullah (2012) conducted the pot experiments in Bangladesh (November to March) to evaluate the effect of water stress on some morphological and physiological parameters of tomato plants, such as growth, yield, flowering and fruiting characters, water consumption, leaf relative water content and transpiration of plants. They selected two tomato cultivars, viz., BARI Tomato-4 and BARI Tomato-5 in their study. Three treatments were imposed viz., 100%, 70%, and 40% of the field capacity (FC). Yield and yield attributes were found high at 70% FC compared with other treatments, water consumption, leaf relative water content, and transpiration decreased with increasing stress.

Yildirim *et al*., (2012) determined the stress level of bell pepper (*Capsicum annum* L.) under different irrigation regimes. Irrigation interval was fixed for all treatments. In the full treatment (100%), water in the root zone was refilled up to field capacity. In another treatment, 20% more water was applied, while in the deficit treatments the water applied was 80%, 50%, 20% and 0% of full irrigation. Vegetation water status was determined by indices SAVI, SR, WBI and NDVI. Of these, NDVI was more sensitive toward distinguishing vegetation water content at different water level applications for a semiarid ecosystem. CWSI values clearly indicated stress development throughout the growing days. It is concluded that bell pepper should be irrigated at 7 day intervals from planting until the 40-50th day after transplanting. Thereafter it should be reduced to 4 days, since during the flowering and fruit formation periods bell pepper is more sensitive to limited water supply.

Water usage is a vital issue for all agricultural crops as well as for ornamental crops. To obtain high quality flowers, it is essential to supply water when it is required. A problem which is common with cut flower growers are determining when to irrigate and the amount of water to apply. Koksal *et al*. (2011) determined the effect of two irrigation intervals (I1: 10 mm pan evaporation and I2: 20 mm pan evaporation) and four pan coefficients (PC_1 = 0.60 Epan, PC_2 = 0.90 Epan, PC_3 = 1.20 Epan and PC_4 = 1.50 Epan) based on the amount of evaporation measured by a Class A Pan (CAP) on flower yield and flower quality of carnation (*Dianthus caryophyllus L.* cv. "Judith") plant grown in a plastic greenhouse and irrigated by a drip irrigation system under Mediterranean conditions was investigated. Irrigation intervals varied from 1 to 6 days in I1 and 4 to12 days in I2 treatments. Both irrigation intervals (I) and pan coefficient (PC) significantly influenced carnation yield. Maximum yields were obtained from the $I1PC_3$ treatment as 6.7 and 6.8 flowers per plant and minimum yields from the I2 PC_1 treatment as 5.6 flowers per plant in the first and second year of the experiment, respectively. Similarly, irrigation intervals and pan coefficient had significant different effects on quality parameters such as flower stem length, flower stem diameter, stem weight, flower diameter, and vase life. Better flower quality was obtained from the treatments of higher frequency irrigations with high pan coefficients compared to lower frequency irrigations with lower pan coefficients. In conclusion, $I1PC_3$ irrigation regime is recommended for growing cut flower carnation in order to obtain higher yield with improved quality.

CHAPTER III

METHODS AND MATERIALS

The experiment was conducted during the period from 01 May to 30 November, 2013.To find out the influence of anti-transpirant and growth retardant on growth and flowering of tuberose under different moisture regimes. The materials and methods that were used for conducting the experiment are presented in this chapter under the following headlines:

3.1 Experimental Site

The experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the study is situated in $23^0$74' Nlatitude and $90^0$35' E longitude.

3.2 Characteristics of soil

The experimental soil belongs to the Modhupur Tract under AEZ No. 28 (UNDP, 1988). The selected experimental plot was medium high land and the soil series was Tejgaon (FAO, 1988). The components of the soil were analyzed in the Soil Testing Laboratory, Soil Resources Development Institute (SRDI) Farmgate, Dhaka and details soil characteristics were presented in Appendix 1.

3.3 Weather condition of the experimental site

The climate of experimental site was under the subtropical, characterized by three distinct seasons, the monsoon or the winter season from November to February and the pre-monsoon period or hot season from March to April ant the monsoon period from May to October (Edris*et al.*, 1979). Meteorological data related to the temperature, relative humidity, rainfalls and sunshine during the period of the experiment was collected from the Bangladesh Meteorological Department, Sher-e-Bangla Nagar, Dhaka and presented in Appendix ii.

3.4 Planting materials

Bulbs of tuberose were used as planting materials and they were collected from the Horticultural Research Centre, Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh.

3.5 Pot soil collection and preparation

The soil was collected one month prior to setting the experiment. The top soil at a 15cm depth was collected from the Horticultural Farm area of North-East corner, mixed thoroughly and makes it clean by removing stones, grass, roots and other debris.

3.6 Fertilizer mix with soil

Recommended dose of organic and inorganic fertilizer was added in the soil prior 21 days of filling the pots and wrapped with polythene sheet.

3.7 Pot preparation

Earthen pots were used in this experiment. The height and width of each pot was 28cm and 44cm respectively. Two holes were made in the middle of the bottom of each pot and holes were covered by the broken pieces of earthen pot. All the pots were washed with ash and tap water by rubbing and sun dried. The fertilizer mixed soil was made well pulverized and dried in the sun. Final check was made to remove plant propagates, inert materials, visible insects and pests.

3.8 Raising of seedlings

Tuberose CV. double bulbs of about 2.5-1.5cm in diameter were planted on May 02, 2013. Pots were placed in a shed and allowed to grow for four weeks at 30-35^0Ctemperature. Plants were irrigated to field condition for another four weeks, to prevent stress, and ensure seedling establishment.

3.9 Irrigation procedure

Gravimetric method was used to find out proper strategy to irrigate pot plants. In this method, earthen pots with soil was weighed using weighing balance and all the earthen pots was made in equal weight including soil which was 11kg where only empty earthen pot was 4kg. Water was added in each pot to make it well saturated condition. The difference between two weights is the evaporation rate. Pot with soil was allowed for two days tying with polythene sheet. After two days, the earthen pot with wetted soil was weighted. The loss of water = weight of pot soil in saturated condition – weight of pot soil after allowing two days. The amount of water lost during the 2 days was recovered completely by irrigation, for control pots only. Other pots received 75% and 50% of the water added to the control plants.

3.10 Anti-transpirant treatment (AT)

A hydrophilic, kaolin particle film, wetting & sticking agent was applied at 3%. AT were prepared using water only. Tuberose plants were sprayed every week interval with fine mist, starting 59 DAP, using a hand pressure sprayer.

3.11 Preparation of Cycocel (CCC)

A 1000ppm stock solution of Cycocel was prepared by dissolving 1ml CCC with distilled water in 1 litre of volumetric flask.

3.12 Treatment of the experiment:

The experiment was set up to investigate the influence of anti-transpirant and growth retardant on growth and flowering of tuberose under different moisture regimes. The study consisted of two factors, which are given below.

Factor A: Different moisture regime

I_o = 100% Evapotranspiration irrigation (Control)

I_1=75% Evapotranspiration irrigation

I_2 = 50% Evapotranspiration irrigation

Factor B: Foliar application of anti-transpirant and growth retardant

F_0 = Foliar spray with water (control)

F_1= Foliar spray with 3% Kaolin

F_2 = Foliar spray with 1000 ppm CCC

F_3=Foliar spray with 3%Kaolin and1000 ppm CCC

3.13 Design and Layout of the Experiment

The experiment was carried out in a Randomized Complete Block Design (RCBD) with 3 replications. 4 plants were exposed to each treatment. The seedlings were planted in the middle of the pot soil and 4 pots were placed in each replication.

3.14 Intercultural operation

When the seedlings started to emerge in the pots it was always kept under careful observation. After emergence of seedlings, various intercultural operations such as weeding, mulching was accomplished for better growth and development of tuberose seedlings.

3.14.1 Weeding

Weeding was done to keep the pots free from weeds, easy aeration of soil, which ultimately ensured better growth and development. The newly emerged weeds were uprooted carefully after complete emergence of seedlings whenever it is necessary. Breaking the crust of the soil was done when needed and it was done for 2 times at 30 DAP and 60 DAP.

3.14.2 Mulching

A layer of dried rice straw was used in each pot as mulch.

3.14.3 Plant Protection

For controlling leaf caterpillars Nogos @ 1ml/L water was applied 2 times at an interval of 10 days starting soon after appearance of infestation. No remarkable attack of disease was found.

3.15 Data collection

Data were recorded on the following parameters from the sample plants during the course of experiment.

3.15.1 Plant height

The height of plant was recorded in centimeter (cm) at 30, 45, 60 and 75 days after planting (DAP) in the experimental plots. The height was measured from the ground level up to the tip of the growing point of the plant.

3.15.2 Number of leaves per plant

All the leaves of individual plants were counted at an interval of 15 days at 30, 45, 60 and 70 days after planting (DAP) in the experimental pots.

3.15.3 Leaf temperature

Leaf temperatures were measured using a leafporometer. Air temperatures were measured close to plants using thermometer. Measurements of leaf and air temperatures were taken in the third day of application of each of the treatment. The day of recording data was fully sunny and data was collected from 12.00 to 1.00 pm. Finally an average was made of the recorded temperature.

3.15.4 Relative water content

Relative water content (RWC) was calculated according to this equation:

RWC= 100 x (FW-DW) / (TW-DW)

Here,

FW= fresh weight of leaf,

TW= turgid weight of leaf,

DW= dry weight of leaf

The uppermost fully expanded leaves that were detached and weighed (FW), then the leaves floated on distilled water at 22-25^{0}C in a dark chamber for 24 hours and after that leaves were weighed (TW). Dry weight was determined after oven drying at 75^{0}C for 48 hours.

3.15.5 CO_2 assimilation rate

Assimilation rate, stomatal conductance and transpiration rate were measured on the first, uppermost expanded leaves of five plants per treatment using LC prometer machine. The measurementswere taken at 12:00 to 1:00 pm.

3.15.6 Measurement of chlorophyll

A leaf from each plant was collected and brings it to the laboratory. The leaf was collected considering a specific distance of plant from the base and the age of the leaf was same which estimated by visual observation. Chlorophyll content was estimated by using SPAD meter. The measured chlorophyll content was expressed as percentage (%).

3.15.7 Length of flowering stalk

Length of flower stalk was measured from the base to the tip of the spike and expressed in centimeter.

3.15.8 Number of spikelet per spike

All the spikelets of the spike were counted from each pot plants.

3.15.9 Number of bulblet per plant

It was calculated from the number of bulblet obtained from all the pot plants.

3.15.10 Weight of bulb

Weight of bulb was recorded from all the pot plants and expressed in gram.

3.15.11 Diameter of bulblets

A slide calipers was used to measure the diameter of the bulblets and expressed in centimeter.

3.15.12 Dry weight of bulb per plant

Dry weight of bulb was determined after drying at 70^0C until steady weight.

3.13 Statistical analysis

The collected data were statistically analyzed to find out the level of significance using MSTAT-C software. The significance of the difference among the treatment mean was estimated by Least Significance Difference (LSD) Test at 1% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to find out the Influence of anti-transpirant and growth retardant on growth & flowering of tuberose under different moisture regimes. The results obtained from the study have been presented, discussed and compared in this chapter through table(s), figures and appendices. The analyses of variance of data in respect of all the parameters have been shown in Appendix IV-XIII. The results have been presented and discussed with the help of table and graphs and possible interpretations given under the following headings.

4.1 Plant height

The plant height of tuberose was measured at 80, 100, 120 and 140 days after planting(DAP). It was evident from Figure 1 and Appendix IV that the height of plant was significantly influenced by different moisture regime at all the sampling dates. At 80, 100, 120 and 140 DAP, 100% evapotranspiration irrigation treatment showed the longest plant (60.08, 63.45, 67.66 and 72.40 cm, respectively) whereas, the shortest plant (56.34, 59.71, 63.92 and 66.00 cm, respectively) was found from 50% ET irrigation treatment. Plant height of a crop depends on the plant vigor, cultural practices, growing environment and agronomic management. In the present experiment since tuberose was grown in the same environment and were given same cultural practices except irrigation. So, the variation of plant height might be due to the effect different moisture regimes.Moftah and Al-Humaid(2005) found that height of tuberose significantly reduced by water deficit treatments, particularly 60% ET regime as compared with the control.

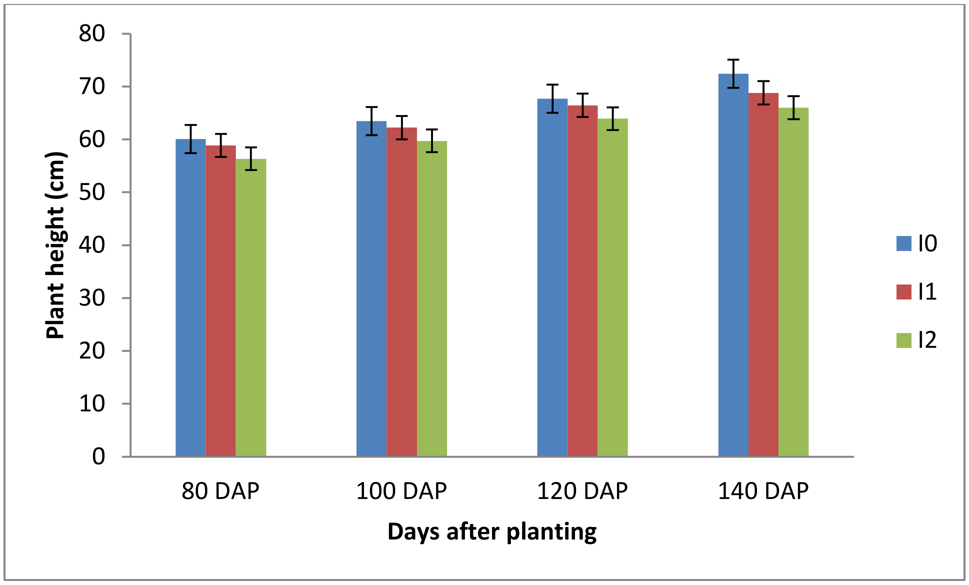


Figure 1. Effect of moisture regimes on plant height of tuberose

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation

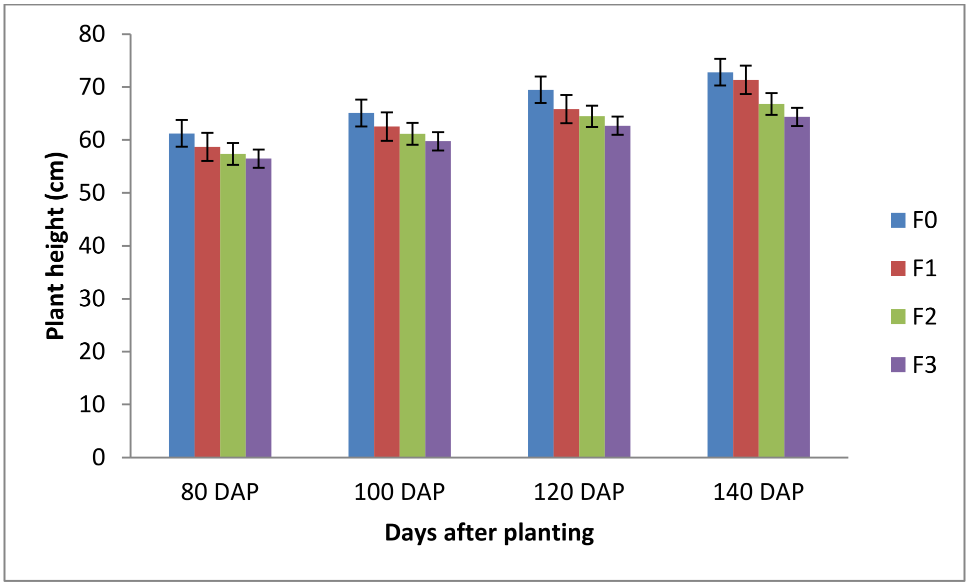


Figure 2. Effect of kaolin and CCC on plant height of tuberose

Note: F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Significant variation of plant height was found due to kaolin and CCC in all the studied durations (Appendix IV and Figure 3). At 80, 100, 120 and 140 DAP, the highest plant (61.23, 65.08, 69.46 and 72.80 cm, respectively) was found in foliar spray with water treatment foliar spray with Kaolin and CCC treatment and lowest plant (56.47, 59.73, 62.69 and 65.33 cm, respectively) was foliar spray with Kaolin and CCC treatment.CCC reduced plant height without any malformation by reducing cell elongation and also by lowering cell division (Rademacher and Jung,1986; kar*et al.*, 1989; Choudhary and Gupta *et al.*, 1996 and Lone, 2001).

Table 1. Interaction effect of moisture regimes and kaolin and CCC on plant height of tuberose at different days after planting (DAP)

Treatments	Plant height (cm) at			
	80 DAP	**100 DAP**	**120 DAP**	**140 DAP**
I_0F_0	63.00 a	67.25 a	72.12 a	74.98 a
I_0F_1	60.00 b	63.49 b	67.76 b	70.62 c
I_0F_2	57.00 d	60.49 cd	64.76 f	67.62 f
I_0F_3	60.70 b	64.19 b	68.46 b	71.32 b
I_1F_0	57.00 d	60.49 cd	64.76 f	67.62 f
I_1F_1	58.00 bc	61.49 c	65.76 de	68.62 e
I_1F_2	59.30 b	62.79 bc	67.06 bc	69.92 d
I_1F_3	58.90 b	62.39 bc	66.66 d	69.52 d
I_2F_0	54.97 f	58.46 f	62.73 g	65.59 g
I_2F_1	58.00 bc	61.49 c	65.76 de	68.62 e
I_2F_2	56.67 e	60.16 d	64.43 f	67.29 f
I_2F_3	52.34 g	55.26 g	59.38 h	62.20 h
$LSD_{(0.05)}$	1.88	1.03	1.26	0.82
CV (%)	4.91	5.38	3.58	4.81

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation; F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Significant Interaction effects of moisture regime and kaolin and CCC on plant height was observed at 80, 100, 120 and 140 DAP (Appendix IV and Table 1). Plant height increased with advanced growing period irrespective ofapplication of kaolin and CCC (Table 1). At 80, 100, 120 and 140 DAP, the tallest plant (63.00, 67.25, 72.12 and 74.98 cm, respectively) was obtained from I_0F_0 treatment whereas, the shortest plant (52.34, 55.26, 59.38 and 62.20 cm, respectively) was obtained from I_2F_3 treatment.

4. 2 Number of leaves per plant

Different irrigation regime exhibited significant variation in results revealed that, the number of leaves per plant of tuberose increased gradually with decreased the irrigation upto 75% at 80, 100, 120 and 140 DAP (Appendix V and Figure 4). At 80, 100, 120 and 140 DAP, the maximum leaves number plant^{-1} (15.57, 26.16, 35.10 and 42.67, respectively) was observed from I_0 treatment and the minimum number (13.60, 20.93, 29.50 and 35.53, respectively) was observed from I_2 treatment. The present study referred that 100% ET irrigationproduced maximum number of leaves.Younis*et al*.(2000) also found that the water deficit on plants inhibited leaf expansion, stem and rootelongation. Therefore, a small decrease in plant water content and turgor can slow downor fully stop growth.

The number of leaves plant^{-1} was significantly influenced by foliar application ofkaolin and CCC at 80, 100, 120 and 140 DAP (Appendix V and Figure 5). At 80, 100, 120 and 140 DAP, the maximum leaves number plant^{-1} (16.90, 28.90, 42.36 and 50.67, respectively) was observed from F_3 treatment whereas, the minimum number (13.10, 22.86, 30.18 and 38.23, respectively) was observed from F_0 treatment. Choudhary and Gupta (1996), observed that total number of leaves per plant of *Catharanthusroseus* increased with the application of CCC over control. Liang *et al*. reported that ATs have the potential to help plants form a well-developed root system for vegetative and reproductive growth.

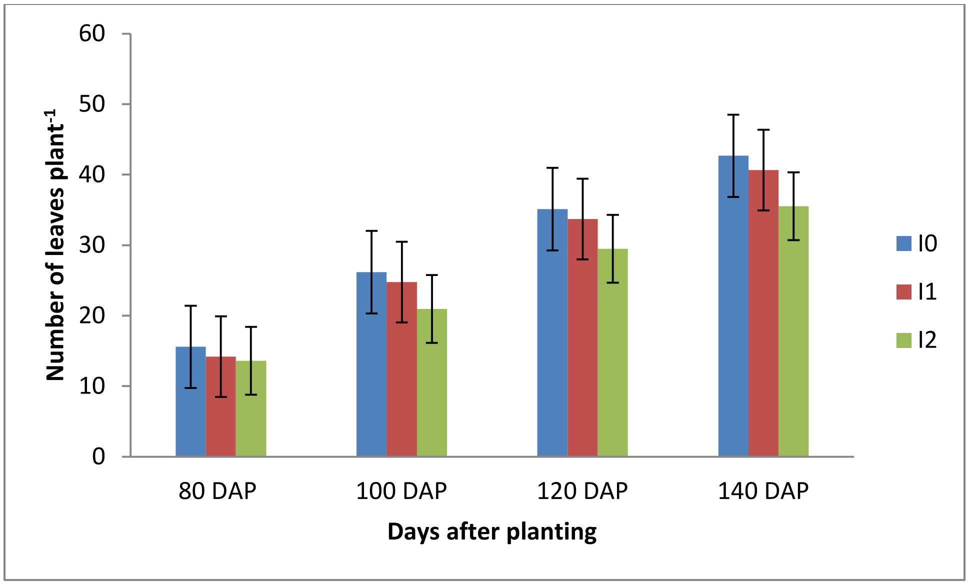


Figure 3. Effect of moisture regimes on number of leaves plant^{-1} of tuberose

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation

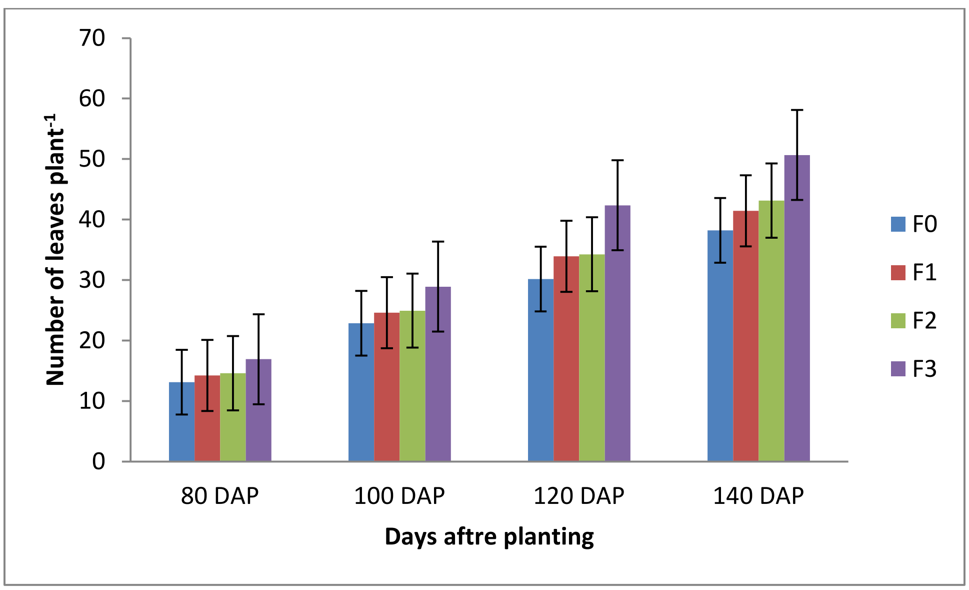


Figure 4. Effect of kaolin and CCC on number of leaves plant^{-1} of tuberose

Note: F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Table 2. Interaction effect of moisture regimes and kaolin and CCCon number of leaves plant^{-1} of tuberose at different days after planting (DAP)

Treatments	Number of leaves plant^{-1} at			
	80 DAP	**100 DAP**	**120 DAP**	**150 DAP**
I_0F_0	14.00 c-e	23.58 bc	31.97 d	42.00 bc
I_0F_1	14.00 c-e	23.68 bc	32.07 c	42.30 bc
I_0F_2	13.70 de	23.38 bc	31.77 d	39.30 cd
I_0F_3	18.00 a	34.53 a	46.92 a	52.70 a
I_1F_0	13.30 e	22.98 cd	31.37 d	36.00 e
I_1F_1	15.70 b	25.38 b	33.77 b	43.00 b
I_1F_2	15.30 b	24.98 b	33.37 b	43.00 b
I_1F_3	15.00 bc	24.68 b	33.07 b	41.00 c
I_2F_0	12.00 f	20.49 e	28.88 e	33.70 f
I_2F_1	13.00 ef	22.68 cd	31.07 d	39.00 cd
I_2F_2	14.70 b-d	24.38 bc	32.77 c	39.70 cd
I_2F_3	14.70 b-d	24.38 bc	32.77 c	42.70 bc
$LSD_{(0.05)}$	1.21	1.03	1.00	1.53
CV (%)	4.95	5.38	7.45	1.99

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation; F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

There was significant variation among the interaction of irrigation and kaolin, CCC on the total numbers of leaves plant^{-1} at 80, 100, 120 and 140 DAP (Appendix V and Table 2). At 80, 100, 120 and 140 DAP, the maximum number of leaves plant^{-1} (18.00, 34.53, 46.92 and 52.70, respectively) was recorded with the combination of 100% ET irrigation and foliar spray with Kaolin &CCC (I_1F_3) treatment whereas, the minimum (12.00, 20.49, 28.88 and 33.70, respectively) was recorded from the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. Present study showed that 100% ET irrigation and foliar spray with Kaolin & CCC produced maximum number of leaves.

4.3 Leaf temperature

Leaf temperature significantly influenced by irrigation regime at 80, 100, 120 and 140 DAP (Appendix VI and Figure 6). At 80, 100, 120 and 140 DAP, 100% ET irrigation produced maximum leaf temperature (37.63^{0}C, 35.69^{0}C, 33.07^{0}C and 31.17^{0}C, respectively) whereas, the minimum was (35.60^{0}C, 33.65^{0}C, 30.27^{0}C and 28.83^{0}C, respectively) I_2 treatment.

Leaf temperature varied significantly with kaolin and CCC at 80, 100, 120 and 140 DAP (Appendix VI and Figure 7). At 90, 80, 100 and 120 DAP, the highest leaf temperature (38.60^{0}C, 36.62^{0}C, 33.97^{0}Cand 32.50^{0}C, respectively) was produced from foliar spray with water and foliar spray with Kaolin while, the lowest (36.34^{0}C, 34.10^{0}C, 30.43^{0}C and 28.29^{0}C, respectively) was found from foliar spray with Kaolin and CCC. Glenn *et al*.(2003) reported that Kaolin reduces leaf temperature by increasing leaf re-flectance. Similar results were observedby Jifon*et al*.(2003) who observed that foliar applications of kaolin reduced leaf temperature at midday (Tlf ≈ 3°C) in grapefruits and apple leaves, respectively.

Interaction effect of different irrigation regime and kaolin, CCC influenced the leaf temperature at 80, 100, 120 and 140 DAP (Appendix VI and Table 3). At 80, 100, 120 and 140 DAP, it was observed that the maximum (39.07^{0}C, 36.93^{0}C, 34.94^{0}C and 32.60^{0}C, respectively) was obtained from I_0F_0 treatment whereas, the minimum (35.30^{0}C, 34.20^{0}C, 31.83^{0}C and 28.27^{0}C, respectively) was recorded from I_2F_3 treatment.

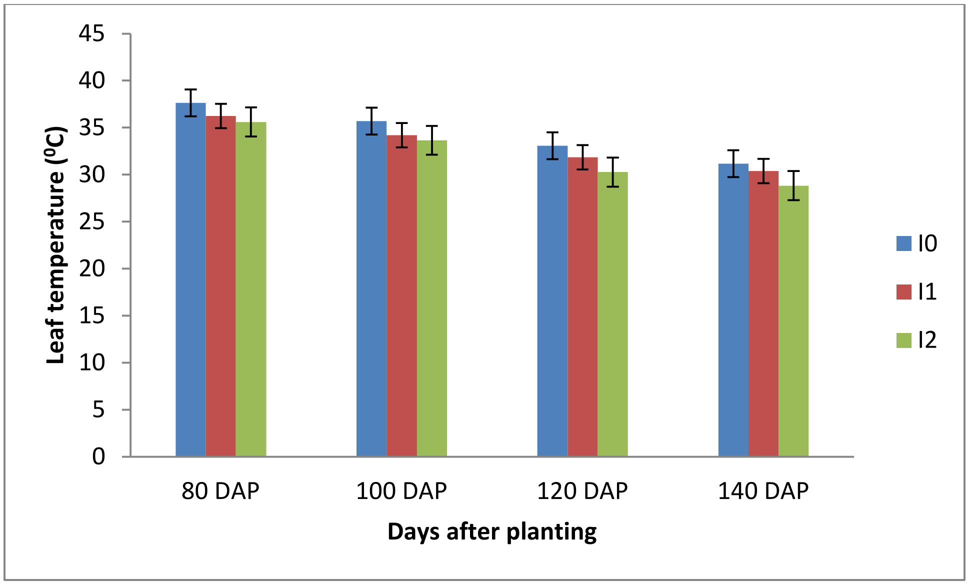


Figure 5. Effect of moisture regimes on leaf temperature of tuberose

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation

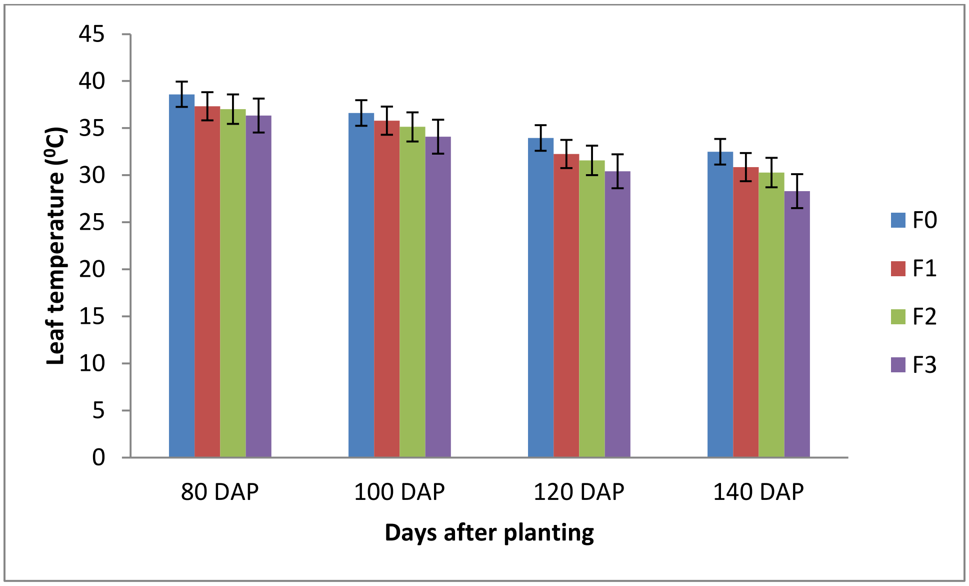


Figure 6. Effect of kaolin and CCC on leaf temperature of tuberose

Note: F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Table 3. Interaction effect of moisture regimes and kaolin and CCC on leaf temperature of tuberose at different days after planting (DAP)

Treatments	Leaf temperature (^{0}C) at			
	80 DAP	**100 DAP**	**120 DAP**	**140 DAP**
I_0F_0	39.07 a	36.93 a	34.94 a	32.60 a
I_0F_1	37.70 b	35.83 b-d	33.69 b-d	30.03 c-e
I_0F_2	37.93 b	35.53 de	33.39 cd	29.83 de
I_0F_3	37.47 b	35.33 ef	33.19 d	30.90 b
I_1F_0	37.93 b	35.80 b-d	33.66 b-d	29.93 de
I_1F_1	37.40 bc	36.07 b	33.93 bc	30.13 b-d
I_1F_2	36.67 de	34.87 g	32.73 e	30.80 bc
I_1F_3	36.70 d	35.77 b-d	33.63 b-d	29.83 de
I_2F_0	36.67 de	35.00 fg	32.86 ef	29.97 c-e
I_2F_1	37.03 cd	35.63 c-e	33.49 cd	30.27 b-d
I_2F_2	36.83 d	36.20 b	34.06 b	30.17 b-d
I_2F_3	35.30 f	34.20 h	31.83 f	28.27 f
$LSD_{(0.05)}$	0.36	0.33	0.50	0.84
CV (%)	3.58	4.56	3.58	1.62

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation; F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

4.4 Relative water content (RWC)

Relative water contentsignifies the water content of plant. The relative water content was significantly influenced by irrigation regime (Appendix VII and Table 4). The highest percentage of RWC (95.78%) was found from I_0 (100% ET irrigation) treatment whereas, the lowest (83.34 %) was obtained from I_2 (50% ET irrigation) treatment. Differences in RWC might be due to the morpho-physiological differences among the irrigation.Moftah and Al-Humaid(2005) found thatRWC decreases underwater deficit conditions. Thereare significant effect of lowRWC on the photosynthetic rate.

Relative water content was influenced by plant growth substance. The highest percentage of RWC (96.37 %) was obtained from F_3 (foliar spray with Kaolin & CCC) treatment and the lowest (80.96 %) was found in F_0 (foliar spray with water) treatment (Appendix VII and Table 5). Atmospheric relative humidity and temperature greatly influence the RWC of plant leaves.

Interaction of irrigation regime and plant growth substance had a significant influence on relative water content of tuberose (Appendix VII and Table 6). The highest percentage of RWC (123.6 %) was obtain from the combination of 100% ET irrigation and foliar spray with Kaolin and CCC (I_0F_3) treatment whereas, the lowest (76.70 %) with the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment.

Table 4. Effect of moisture regime on relative water content and number of spikelet per spike of tuberose

Treatments	Relative water content (%)	Number of spikelet per plant
I_0	95.78 a	52.50 a
I_1	88.87 b	47.64 b
I_2	83.38 c	34.20 c
$LSD_{(0.05)}$	2.71	1.73
CV (%)	2.09	2.64

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation

Table 5. Effect of Kaolin and CCC on relative water content and number of spiklete per spike of tuberose

Treatments	Relative water content (%)	Number of spikelet per plant
F_0	80.96 d	40.41 c
F_1	92.04 b	42.78 b
F_2	96.37 a	43.89 b
F_3	87.99 c	50.04 a
$LSD_{(0.05)}$	3.13	2.00
CV (%)	2.09	2.64

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

4.5Number of spikelet per spike

Number of spikelet per plant signifies the water content of plant. Number of spikelet per spike content was significantly influenced by irrigation regime (Appendix VII and Table 4). The highest spike per plant (52.50) was found from the100% ET irrigation whereas, the lowest (34.20) was obtained from the 50% ET irrigation.

Number of spikelet per spike was influenced by plant growth substance. The highest spike per plant (50.02) was obtained from the foliar spray with Kaolin & CCC whereas, the lowest (40.41) was recorded in the foliar spray with water (Appendix VII and table 5).

Interaction of irrigation regime and plant growth substance had a significant influence on number of spike per plant of tuberose (Appendix VII and Table 6). The highest spike per plant (60.00) was obtain from the combination of 100% ET irrigation and foliar spray with Kaolin and CCC (I_0F_3) treatment whereas, the lowest (29.00) with the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment.

Table 6. Interaction effect of moisture regimes and Kaolin and CCC on relative water content and number of spiklet per spike of tuberose

Treatments	Relative water content (%)	Number of spikelet per spike
I_0F_0	93.09 b	54.33 b
I_0F_1	75.40 g	51.33 c
I_0F_2	90.98 bc	44.33 ef
I_0F_3	123.6 a	60.00 a
I_1F_0	90.66 c-d	42.89 f
I_1F_1	80.86 f	45.22 e
I_1F_2	86.31 e	48.67 d
I_1F_3	92.39 b	53.78 b
I_2F_0	76.70 g	29.00 j
I_2F_1	88.63 c-e	31.78 i
I_2F_2	86.69 e	38.67 g
I_2F_3	87.75 de	36.33 h
$LSD_{(0.05)}$	3.13	2.00
CV (%)	2.09	2.64

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation; F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

4.6Chlorophyll content of leaves (SPAD value)

Chlorophyll content of tuberose leaves were significantly affected by the irrigation regime at 80 and 140 DAP (Appendix VIII and Figure 8). The maximum chlorophyll content (SPAD value) (63.56 and 54.93 %, respectively) was recorded from I_1 treatment whereas, the minimum (60.28 and 49.48 %, respectively) was recorded from I_2 treatment. The increase in chlorophyll content under mild water stress may be due to the increased thickness of leaves and compacted mesophyll cells of stressed-leaves, consequently more chloroplasts per unit area as often in the case under stress conditions (Delperee*et al.*, 2003). Prakash and Ramachandran (2000b) found that in *Solanummelongena*, moisture stress would have inhibited the biosynthesis of chlorophyll *a* precursor, which in turn would have reduced the total chlorophyll content.

Chlorophyll content of tuberose leaves were significantly affected by foliar application of kaolin and CCC at 80 and 140 DAP (Appendix VIII and Figure 9). Thehighest chlorophyll content (SPAD value) (64.70 and 60.81 %, respectively) was recorded from F_3 treatment whereas, the minimum (53.39 and 49.37 %, respectively) was recorded from F_0 treatment.Moftah and Al-Humaid(2005), found that under 80% irrigation regime, Kaolin treatments significantly increased chlorophyll content in water stressed-plants compared to the control plants. Grewal*et al.*, (1993) found that cyocel at 250 and 500 ppm significantly improved the chlorophyll contents in leaves of *Brassica napus.*

Interaction effect of different irrigation regime and kaolin, CCC in terms of chlorophyll content at 80 and 140 DAP (Appendix VIII and Table 8). The maximum chlorophyll content (SPAD value) (67.50 and 55.98 %, respectively) was recorded from the combination of 100% ET irrigation and foliar spray with Kaolin & CCC (I_1F_3) treatment. On the other hand, the minimum chlorophyll content (SPAD value) (58.80 and 49.00 %, respectively) was recorded from the combination of50% ET irrigation and foliar spray with water (I_2F_0) treatment.

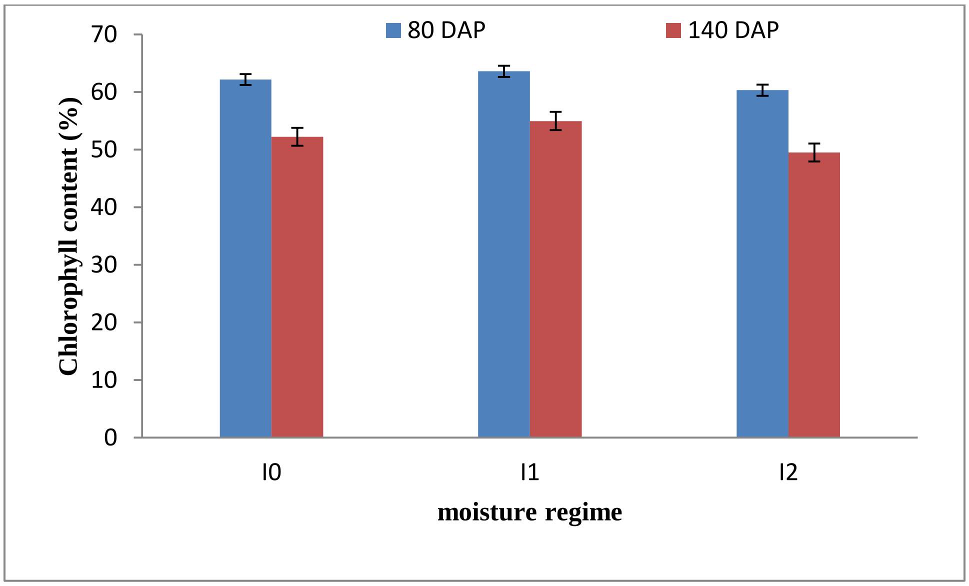


Figure 7. Effect of moisture regimes on chlorophyll content of tuberose

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation

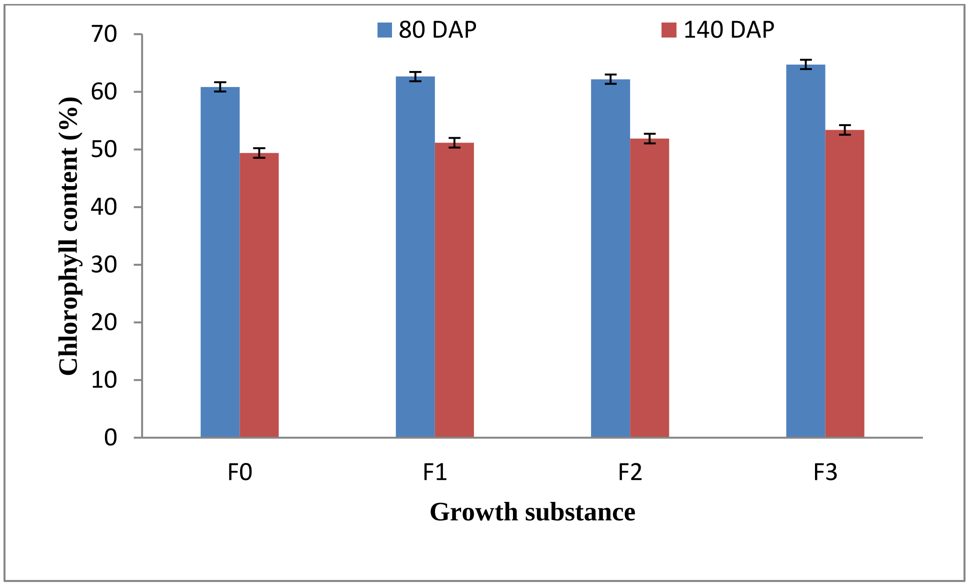


Figure 8. Effect of kaolin and CCC on chlorophyll content of tuberose

Note: F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Table 7. Interaction effect of irrigation and kaolin and CCC on chlorophyll content (SPDA value) of tuberose at different days after planting (DAP)

Treatments	Chlorophyll content (SPAD value) at	
	80 DAP	**140 DAP**
I_0F_0	60.81 f	51.29g
I_0F_1	63.70 c	55.27 b
I_0F_2	62.63 d	53.48 d
I_0F_3	67.50 a	55.98 a
I_1F_0	62.63 d	53.49 d
I_1F_1	62.10 e	52.49 e
I_1F_2	64.30 b	55.34 b
I_1F_3	60.10 g	51.94 f
I_2F_0	58.80 h	49.00 h
I_2F_1	64.70 b	54.90 c
I_2F_2	61.93 e	53.45 d
I_2F_3	62.13 e	51.58 fg
$LSD_{(0.05)}$	0.44	0.50
CV (%)	3.42	4.29

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation; F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

4.7 CO_2 assimilation

Different irrigation regime significantly influenced CO_2 assimilation of tuberose at 80, 100, 120 and 140 DAP (Appendix X and Figure 10). At 80, 100, 120 and 140 DAP, the highest CO_2 assimilation (1.65, 2.78, 3.69 and 4.65, respectively) was found in I_0treatment and the lowest (1.07, 1.79, 2.59 and 3.12, respectively) was found in I_2 treatment. Study referred that 100% ET irrigation exposed best result in terms of CO_2 assimilation. Photosynthetic CO_2 assimilation (*A*) and transpiration (*E*) rates were significantly lower in water-stressed tuberose plants relative to non-stressed plants at all growth stages.

Foliar application of kaolin and CCC significantly influenced CO_2 assimilation of tuberose at 80, 100, 120 and 140 DAP (Appendix X and Figure 11). At 80, 100, 120 and 140 DAP, the highest CO_2 assimilation (1.93, 3.06, 4.38 and 5.33, respectively) was recorded fromF_3 treatment whereas, the lowest (1.10, 2.17, 2.58 and 3.00, respectively) was counted from F_0 treatment. The study of Glenn *et al.* (2003) on the use and effect of Kaolin indicated that the reflective coating spray on plants under water stress provided more benefit in reducing the heat load than a reduction in CO2 assimilation due to light obstruction.

CO_2 assimilation of tuberose significantly influenced by the Interaction effect of irrigation and kaolin, CCC at 80, 100, 120 and 140 DAP (Appendix X and Table 9). At 80, 100, 120 and 140 DAP, the maximum CO_2 assimilation (2.40, 3.38, 4.74 and 5.90, respectively) was recorded from the combination of 100% ET irrigation and foliar spray with Kaolin and CCC (I_1F_3) treatment. On the other hand, the lowest CO_2 assimilation (1.00, 1.53, 2.11 and 3.20, respectively) was recorded from the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. The study indicated that 100% ET irrigation and foliar spray with Kaolin and CCC revealed better performance in terms of CO_2 assimilation of tuberose.

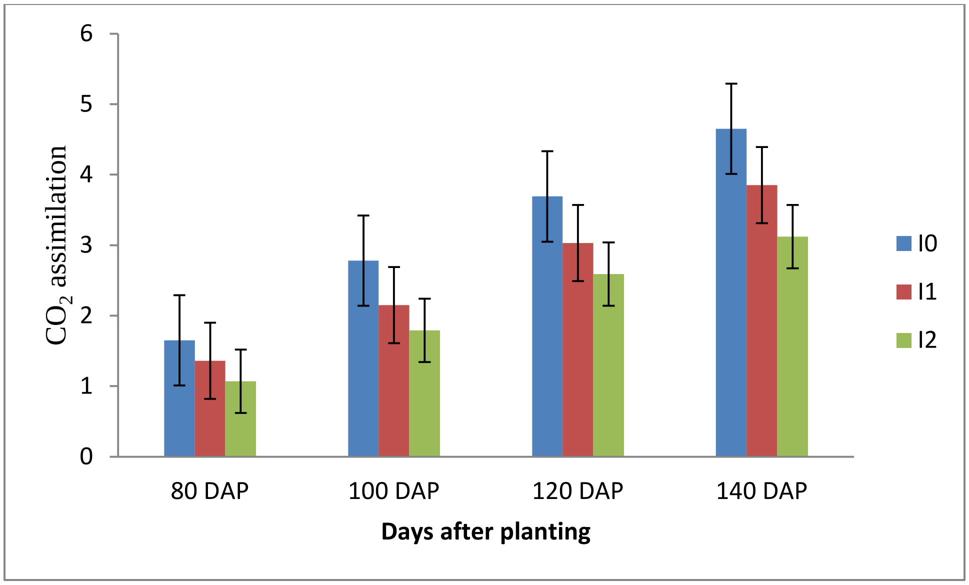


Figure 9. Effect of moisture regimes on CO_2 assimilation of tuberose

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation

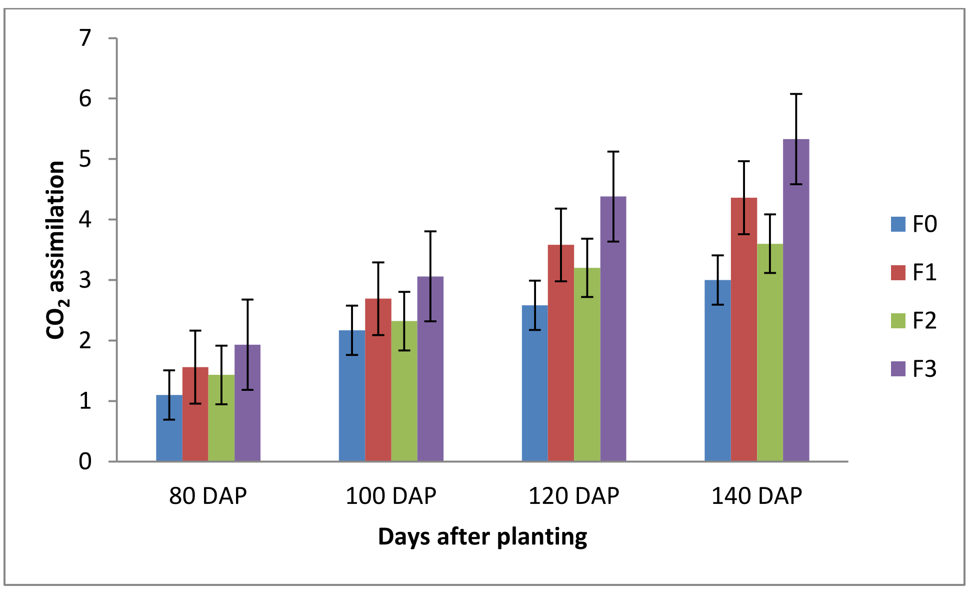


Figure 10. Effect of kaolin and CCC on CO_2 assimilation of tuberose

Note: F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Table 8. Interaction effect of moisture regime and kaolin and CCC on CO_2 assimilation of tuberose at different days after planting (DAP)

Treatments	CO_2 assimilation at			
	80 DAP	**100 DAP**	**120 DAP**	**140 DAP**
I_0F_0	1.30 fg	1.83 e-g	2.51 ef	4.30 b-d
I_0F_1	2.10 b	2.63 b	3.31 b	4.06 c-e
I_0F_2	1.80 cd	2.33 bc	3.01 bc	3.80 e
I_0F_3	2.40 a	3.38 a	4.74 a	5.90 a
I_1F_0	1.30 fg	1.83 e-g	2.51 ef	4.50 bc
I_1F_1	1.70 c-e	2.23 de	2.91 cd	3.80 e
I_1F_2	1.60 de	2.13 ef	2.81 cd	3.90 de
I_1F_3	1.80 cd	2.33 b-d	3.01 bc	5.40 b
I_2F_0	1.00 h	1.53 h	2.11 g	3.20 f
I_2F_1	1.30 fg	1.83 e-g	2.51 ef	4.50 bc
I_2F_2	1.50 ef	2.03 ef	2.71 de	4.70 b
I_2F_3	1.90 bc	2.43 b-d	3.11 b	5.40 b
$LSD_{(0.05)}$	0.26	0.30	0.37	0.45
CV (%)	10.03	7.45	6.59	6.68

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation; F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

4.8Evapotranspiration rate (ET)

Different irrigation regime significantly influenced transpiration rate of tuberose at 80, 100, 120 and 140 DAP (Appendix XI and Figure 12). At 80, 100, 120 and 140 DAP, the highest transpiration rate (0.32, 0.87, 1.32 and 1.50, respectively) was found form 100% ET irrigation (I_0)treatment whereas, the lowest (0.20, 0.55, 0.71 and 1.05, respectively) was recorded from 50% ET irrigation (I_2) treatment. Study referred that 100% ET irrigation exposed best result in terms of evaporation rate.Moftahand Al-Humaid (2005), found that transpiration (*E*) rates were significantly lower in water-stressed tuberose plants relative to non-stressed plants at all growth stages.

Foliar application of kaolin and CCC significantly influenced transpiration rate of tuberose at 80, 100, 120 and 140 DAP (Appendix XI and Figure 13). At 80, 100, 120 and 140 DAP, the highest evaporation rate (0.43, 0.94, 1.27 and 1.47, respectively) was recorded from foliar spray with Kaolin and CCC (F_3) treatment whereas, the lowest (0.22, 0.58, 0.76 and 0.98, respectively) was counted from foliar spray with water (F_0) treatment.Water stress significantly reduced transpiration rate (*E)*, while antitranspirants enhanced it either at 60% or 80% ET irrigation Moftah and Al-Humaid (2005), observed that in tuberose plants.

Transpiration rate of tuberose significantly influenced by the Interaction effect of irrigation and plant growth substance at 80, 100, 120 and 140 DAP (Appendix XI and Table 10). At 80, 100, 120 and 140 DAP, the maximum transpiration rate (0.56, 1.06, 1.49 and 1.91, respectively) was recorded from the combination of 100% ET irrigation and foliar spray with Kaolin and CCC (I_0F_3) treatment. On the other hand, the lowest transpiration rate (0.18, 0.30, 0.66 and 0.71, respectively) was recorded from the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. The study indicated that 100% ET irrigation and foliar spray with Kaolin and CCC revealed better performance in terms of transpiration rate of tuberose.

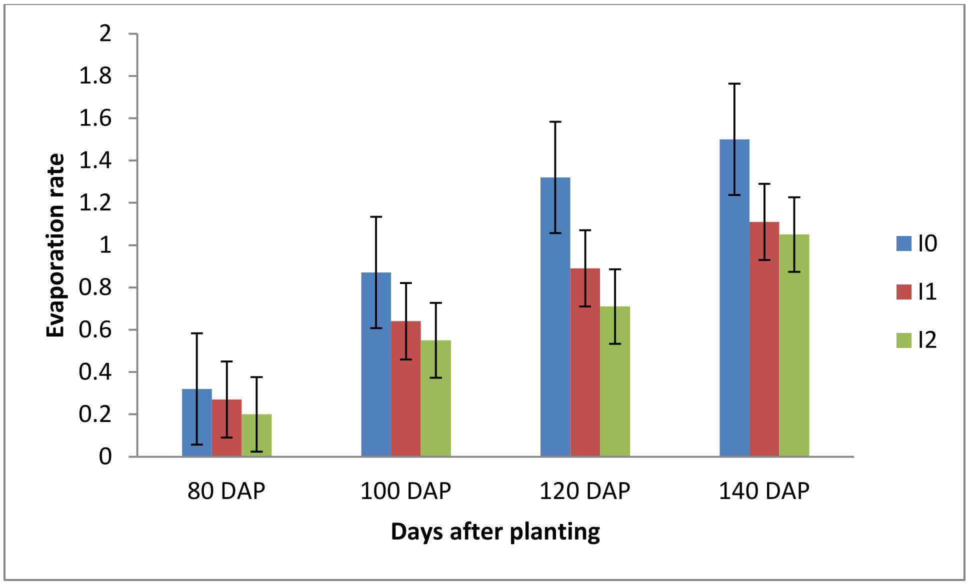


Figure 11. Effect of moisture regimes on evapotranspiration rate of tuberose

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation

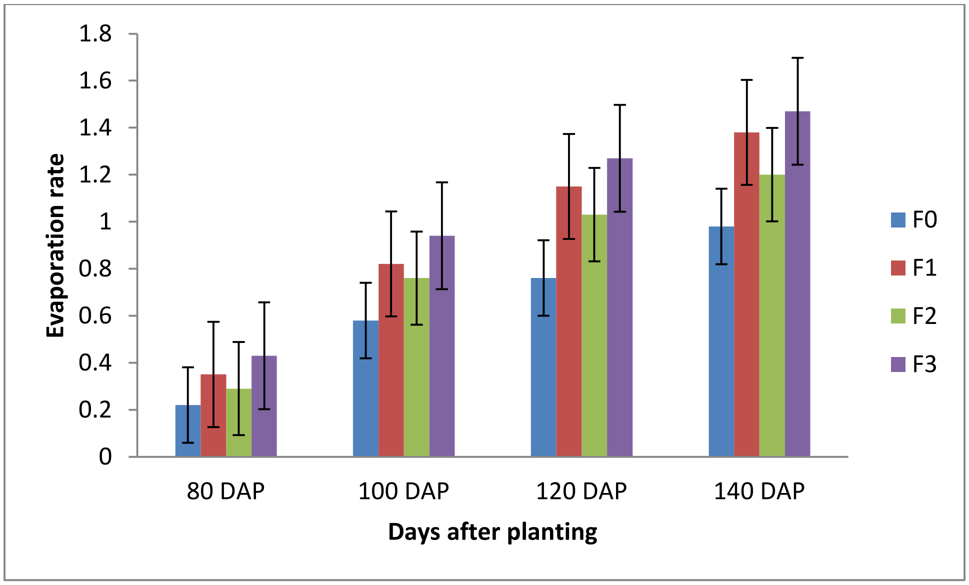


Figure 12. Effect of kaolin and CCC on evapotranspitration rate of tuberose

Note: F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Table 9. Interaction effect of moisture regimes and kaolin and CCC on evapotranspiration rate of tuberose at different days after planting (DAP)

Treatments	Evapotranspiration rate at			
	80 DAP	**100 DAP**	**120 DAP**	**140 DAP**
I_0F_0	0.22 e-g	0.44 de	0.70 d	0.93 h
I_0F_1	0.25 d-f	0.47 de	0.73 e	0.94 h
I_0F_2	0.25 d-f	0.67 c	0.93 c	1.36 d
I_0F_3	0.56 a	1.06 a	1.49 a	1.91 a
I_1F_0	0.26 c-e	0.48 de	0.74 d	1.07 g
I_1F_1	0.20 fg	0.72 c	0.98 c	1.30 e
I_1F_2	0.27 c-e	0.89 b	1.25 b	1.73 b
I_1F_3	0.47 b	0.69 c	0.95 c	1.24 f
I_2F_0	0.18 g	0.30 f	0.66 f	0.71 j
I_2F_1	0.28 cd	0.50 d	0.76 d	1.62 c
I_2F_2	0.31 c	0.53 d	0.79 d	0.82 i
I_2F_3	0.26 c-e	0.48 de	0.74 e	1.07 g
$LSD_{(0.05)}$	0.05	0.11	0.07	0.05
CV (%)	11.01	8.48	10.75	2.50

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation; F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

4.9 Number of bulbs

Different irrigation regime exhibited significant variation in respect, results revealed that, the number of bulbs of tuberose increased gradually with decreased the irrigation upto 75% (Appendix XII and Table 11). The maximum bulbs number (24.08) was observed from I_1 treatment whereas, the minimum (18.68) was observed from I_2 treatment. The present study referred that 75% ET irrigationproduced maximum number of bulbs.

The number of bulbs was significantly influenced by kaolin and CCC (Appendix XII and Table 12). The highestbulbs number (23.78) was observed from F_3 treatmentwhereas, the minimum number (19.33) was observed from F_0 treatment.

There was significant variation among the interaction of irrigation and application of kaolin and CCC on numbers of bulbs (Appendix XII and Table 13). The maximum number of bulbs (25.67) was recorded with the combination of 75% ET irrigation and foliar spray with Kaolin & CCC (I_1F_3) treatment whereas, the minimum (16.00) was recorded from the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. Present study reaveled that 100% ET irrigation and foliar spray with Kaolin & CCC produced maximum number of bulbs.

4.10 Diameter of bulb

Significant difference was found on diameter of bulb for the different irrigation regime (Appendix XII and Table 11). The highest diameter of bulb (4.10 cm) was found from I_1 treatment while, the lowest (3.30 cm) was observed from I_2 treatment.

Foliar application of kaolin and CCC differed non significantly on diameter of bulb of tuberose (Appendix XII and Table 12). But numerically, the highest diameter of bulb (3.93 cm) was found from F_3 (foliar spray with Kaolin and CCC) treatment whereas, the lowest (3.26 cm) was found from F_0(foliar spray with water) treatment.

Table 10. Effect of moisture regimes on bulb yield of tuberose

Treatments	Number of bulb	Diameter of bulb (cm)	Weight of bulb (g)	Bulb dry weight (g)
I_0	21.83 b	3.62 b	144.0 b	37.14 b
I_1	24.08 a	4.10 a	168.8 a	38.97 a
I_2	18.68 c	3.30 c	104.5 c	35.72 c
$LSD_{(0.05)}$	1.15	0.31	9.66	0.42
CV (%)	3.64	5.80	4.74	2.77

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation

Table 11. Effect of kaolin and CCC on bulb yield of tuberose

Treatments	Number of bulb	Diameter of bulb (cm)	Weight of bulb (g)	Bulb dry weight (g)
F_0	19.33 c	3.26 c	125.3 c	36.02 c
F_1	21.44 b	3.56 b	138.0 b	37.41 b
F_2	21.57 b	3.63 b	140.3 b	37.07 b
F_3	23.78 a	3.93 a	152.7 a	38.62 a
$LSD_{(0.05)}$	1.32	0.23	11.16	0.48
CV (%)	3.64	5.80	4.74	2.77

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Significant variation was recorded due to combined effect of different irrigation regime and kaolin, CCC in terms of diameter of bulb of tuberose (Appendix XII and Table 13). The maximum diameter of bulb (4.40 cm) was recorded from the treatment combination of I_1F_3 treatment whereas, the minimum diameter of bulb (3.20 cm) was recorded from I_1F_2 treatment.

4.11 Weight of bulb

Weight of bulb showed statistically significant differed due to the different irrigation regime (Appendix XII and Tabel11). The highest weight of bulb (168.80 g) was observed from the 75% ET irrigation. On the other hand, the lowest weight of bulb (104.50 g) was found from the 50% ET irrigation.

Application of kaolin and CCC differed significantly on the weight of bulb of tuberose (Appendix XII and Table 12). The highest weight of bulb (152.70 g) was observed fromfoliar spray with Kaolin and CCC. On the other hand, the lowest weight of bulb (125.30 g) was found from foliar spray with water.Interaction effect of different irrigation regime and plant growth substance varied significantly in terms of weight of bulb of tuberose (Appendix XII and Table 13). The maximum weight of bulb (194.00 g) was observed in I_1F_3 treatment (75% ET irrigation and foliar spray with Kaolin and CCC)whereas, the minimum (70.00 g) was observed from I_2F_0 treatment.Manloy (1989) on iris concluded that bulb size and bulb weight were increased by CCC or Alar treatments.

4.12 Bulb dry weight

Weight of dry bulb showed statistically significant differed due to the different irrigation regime (Appendix XII and Tabel 11). The highest weight of dry bulb (38.97 g) was observed from the 75% ET irrigation treatment. On the other hand, the lowest weight of dry bulb (35.72 g) was found from the 50% ET irrigation treatment.

Foliar application of kaolin and CCC differed significantly on the weight of dry bulb of tuberose (Appendix XII and Table 12). The highest weight of dry bulb (38.62 g) was observed from foliar spray with Kaolin and CCC treatment. On the other hand, the lowest weight of bulb (36.02 g) was found from foliar spray with water treatment.

Table 12. Interaction effect of moisture regimes and kaolin and CCC on bulb yield of tuberose

Treatments	Number of bulb	Diameter of bulb (cm)	Weight of bulb (g)	Bulb dry weight (g)
I_0F_0	24.00 bc	3.66 cd	190.0 a	41.93 b
I_0F_1	21.70 de	3.66 cd	138.0 c	37.30 d
I_0F_2	21.30 ef	3.63 d	161.0 b	33.67 h
I_0F_3	20.33 f	3.73 cd	87.00 d	35.67 g
I_1F_0	24.00 bc	3.73 cd	154.0 b	38.00 c
I_1F_1	22.30 de	3.50 de	187.0 a	38.00 c
I_1F_2	24.33 b	3.60 d	140.0 c	36.20 ef
I_1F_3	25.67 a	4.40 a	194.0 a	43.70 a
I_2F_0	16.00 i	3.20 e	70.00 e	32.30 i
I_2F_1	17.33 h	4.20 ab	96.00 d	35.90 fg
I_2F_2	22.70 cd	4.00 bc	156.0 b	38.20 c
I_2F_3	18.70 g	3.80 cd	96.00 d	36.50 e
$LSD_{(0.05)}$	1.32	0.35	11.16	0.48
CV (%)	3.64	5.80	4.74	2.77

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation; F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Interaction effect of different irrigation regime and kaolin, CCC varied significantly in terms of weight of dry bulb of tuberose (Appendix XII and Table 13). The maximum weight of bulb (43.70 g) was observed in I_1F_3 (75% ET irrigation and foliar spray with Kaolin and CCC) treatment whereas, the minimum (32.30 g) was observed from I_2F_0(50% ET irrigation and foliar spray with water) treatment.

4. 13Length of flowering stalk

Length of flowering stalk of tuberose were significantly affected by the irrigation regime (Appendix XIII and Table 14). The maximum length of flowering stalk (94.65 cm) was recorded from I_0 treatment. On the other hand, the minimumength of flowering stalk (81.25 cm) was recorded from I_2 treatment.

Length of flowering stalk of tuberose leaves were significantly affected by foliar application of kaolin and CCC (Appendix XIII and Table 15). The highest length of flowering stalk (91.00 cm) was recorded from F_0 treatment. On the other hand, the lowest length of flowering stalk (78.77 cm) was recorded from F_3 treatment.

Table 13. Effect of moisture regimes on length of flowering stalk and length of rachis of tuberose

Treatments	Length of flowering stalk (cm)	Length of rachis (cm)
I_0	94.65 a	31.27 a
I_1	88.36 b	29.60 b
I_2	81.25 c	28.10 c
$LSD_{(0.05)}$	2.22	0.85
CV (%)	1.77	1.95

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation

Table 14. Effect of kaolin and CCC on length of flowering stalk and length of rachis of tuberose

Treatments	Length of flowering stalk (cm)	Length of rachis (cm)
F_0	91.00 a	31.80 a
F_1	87.33 b	30.70 b
F_2	82.00 c	29.80 b
F_3	78.77 d	26.33 c
$LSD_{(0.05)}$	2.56	0.97
CV (%)	1.77	1.95

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

Interaction effect of different irrigation regime and plant growth substance in terms of length of flowering stalk (Appendix XIII and Table 16). The maximum length of flowering stalk (103.00 cm) was recorded from the combination of 100% ET irrigation and foliar spray with water treatment whereas, the minimum (71.70 cm) was recorded from the combination of 50% ET irrigation and foliar spray with kaolin and CCC (I_2F_3) treatment.

4. 14Length of rachis

Different irrigation regime exhibited significant variation in respect, results revealed that, length of rachis of tuberose increased gradually with increased the irrigation upto 100% (Appendix XIII and Table 14). The maximum length of rachis (31.27 cm) was observed from 100% ET irrigation(I_0) treatment whereas, the minimum (21.00 cm) was observed from 50% ET irrigation(I_2) treatment. The present study referred that 100% ET irrigationproduced height length of rachis.

Length of rachis was significantly influenced by kaolin and CCC (Appendix XIII and Table 15). The highest length of rachis (31.80 cm) was observed from foliar spray with water (F_0) treatment whereas, the lowest (26.33 cm) was observed from foliar spray with Kaolin and CCC(F_3) treatment.

There was significant variation among the interaction of irrigation and kaolin, CCC on length of rachis (Appendix XIII and Table 16). The maximum length of rachis area (38.70 cm) was recorded with the combination of 100% ET irrigation and foliar spray with water (I_0F_0) treatment whereas, the minimum (21.00 cm) was recorded from the combination of 50% ET irrigation and foliar spray withkaolin and CCC **(**I_2F_3). Present study revealed that 100% ET irrigation and foliar spray with water produced maximum length of rachis.

Table 15. Interaction effect of moisture regimes and kaolin and CCCon length of flowering stalk and length of rachis of tuberose

Treatments	Length of flowering stalk (cm)	Length of rachis (cm)
I_0F_0	103.00 a	38.70 a
I_0F_1	80.70 fg	32.70 d
I_0F_2	63.30 i	22.70 g
I_0F_3	86.70 e	30.70 e
I_1F_0	82.30 f	23.00 g
I_1F_1	98.30 b	25.70 f
I_1F_2	95.00 c	31.00 e
I_1F_3	92.00 d	35.00 b
I_2F_0	78.30 g	26.00 f
I_2F_1	94.00 cd	33.70 c
I_2F_2	81.00 f	35.70 b
I_2F_3	71.70 h	21.00 h
$LSD_{(0.05)}$	2.56	0.97
CV (%)	1.77	1.95

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 level of probability

Note: I_o = 100% ET irrigation (Control), I_1=75% ET irrigation and I_2 = 50% ET irrigation; F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC and F_3=Foliar spray with Kaolin and CCC

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at Horticultural Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to determine the growth and flowering of tuberose in response to anti-transpirant and growth retardant under different moisture regime. The experiment consisted two factors: Factor A: Different moisture regime I_0=100% evapotranspiration irrigation control, I_1 = 75% evapotranspiration irrigation control, I_2=50% evapotranspiration irrigation; Factor B: Foliar application of anti-transpirant and growth retardent F_0 = Foliar spray with water (control), F_1= Foliar spray with kaolin, F_2 = Foliar spray with CCC, F_3=Foliar spray with Kaolin and CCC. There were 12 treatments combination. The two factorial experiment was laid out in Complete Randomized Design (CRD) with five replications. Data on growth and flowering contributing characters were recorded and significant variations was observed.

In case of irrigation treatment, at 80, 100, 120 and 140 DAP, the longest plant (60.08, 63.45, 67.66 and 72.40 cm, respectively) was recorded from I_o treatment while, the shortest plant (56.34, 59.71, 63.92 and 66.00 cm, respectively) was found from I_2 irrigation treatment. The maximum leaves number plant^{-1} (15.57, 26.16, 35.10 and 42.67, respectively) was recorded from I_0 treatment and the minimum number (13.60, 20.93, 29.50 and 35.53, respectively) was recorded from I_2 treatment. 100% ET irrigation produced maximum leaf temperature (37.63^{0}C, 35.69^{0}C, 33.07^{0}C and 31.17^{0}C, respectively) while, the minimum was recorded from (35.60^{0}C, 33.65^{0}C, 30.27^{0}C and 28.83^{0}C) I_2 treatment. The highest percentage of RWC (95.78 %) was found from I_0 (100% ET irrigation) treatment whereas, the lowest (83.34 %) was obtained from I_2 (50% ET irrigation) treatment. The maximum chlorophyll content (SPAD value) (63.56 and 54.93 %, respectively) was recorded from I_1 treatment whereas, the minimum (60.28 and 49.48 %, respectively) was recorded from I_2 treatment. At 80, 100, 120 and 140 DAP, 100% ET irrigation (I_0) treatment produced highest stomatal conductance (20.58, 29.96, 37.98 and 54.26 mmol ms^{-2}, respectively) whereas, the lowest (17.17, 25.55, 33.02 and 39.71 mmol ms^{-2}, respectively) was found from 50% ET irrigation (I_2) treatment. At 80, 100, 120 and 140 DAP, the highest CO_2 assimilation (1.65, 2.78, 3.69 and 4.65, respectively) was found in I_0 treatment and the lowest (1.07, 1.79, 2.59 and 3.12, respectively) was found in I_2 treatment. At 80, 100, 120 and 140 DAP, the highest transpiration rate (0.32, 0.87, 1.32 and 1.50, respectively) was found form 100% ET irrigation (I_0) treatment whereas, the lowest (0.20, 0.55, 0.71 and 1.05, respectively) was recorded from 50% ET irrigation (I_2) treatment. The maximum bulbs number (24.08) was observed from I_1 treatment whereas, the minimum (18.68) was observed from I_2 treatment. The highest diameter of bulb (4.10 cm) was found from I_1 treatment while, the lowest (3.30 cm) was observed from I_2 treatment. The highest weight of bulb (168.80 g) was observed from the 75% ET irrigation. On the other hand, the lowest weight of bulb (104.50 g) was found from the 50% ET irrigation. The highest weight of dry bulb (38.97 g) was observed from the 75% ET irrigation treatment. On the other hand, the lowest weight of dry bulb (35.72 g) was found from the 50% ET irrigation treatment. The maximum length of flowering stalk (94.65 cm) was recorded from I_0 treatment. On the other hand, the minimum length of flowering stalk (81.25 cm) was recorded from I_2 treatment. The maximum length of rachis (31.27 cm) was observed from 100% ET irrigation (I_0) treatment whereas, the minimum (28.10 cm) was observed from 50% ET irrigation (I_2) treatment. The highest spikelet per spike (52.50) was found from the 100% ET irrigation whereas, the lowest (34.20) was obtained from the 50% ET irrigation.

For application of kaolin and CCC at 80, 100, 120 and 140 DAP, the highest plant height (61.23, 65.08, 69.46 and 72.80 cm, respectively) was found in foliar spray with water and lowest plant (56.47, 59.73, 62.69 and 65.33 cm, respectively) was foliar spray with Kaolin and CCC treatment. The maximum leaves number $plant^{-1}$ (16.90, 28.90, 42.36 and 50.67, respectively) was observed from F_3 treatment whereas, the minimum number (13.10, 22.86, 30.18 and 38.23, respectively) was observed from F_0 treatment. The highest leaf temperature (38.60^0C, 36.62^0C, 33.97^0C and 32.50^0C, respectively) was produced from foliar spray with water foliar spray with Kaolin while, the lowest

(36.34^0C, 34.10^0C, 30.43^0C and 28.29^0C, respectively) was found from foliar spray with Kaolin and CCC. The highest percentage of RWC (96.37 %) was obtained from F_3 (foliar spray with Kaolin & CCC) treatment and the lowest (80.96 %) was found in F_0 (foliar spray with water).The highest chlorophyll content (SPAD value) (64.70 and 60.81 %, respectively) was recorded from F_3 treatment whereas, the minimum (53.39 and 49.37 %, respectively) was recorded from F_0 treatment. Stomatal conductance varied significantly with different plant growth substance at 80, 100, 120 and 140 DAP At 80, 100, 120 and 140 DAP, the maximum stomatal conductance (19.57, 29.14, 37.50 and 444.84 mmol ms^{-2}, respectively) was produced from F_3 treatment whereas, minimum (16.53, 24.91, 32.33 and 38.27 mmol ms^{-2}, respectively) was found from F_0 treatment. The highest CO_2 assimilation (1.93, 3.06, 4.38 and 5.33, respectively) was recorded from F_3 treatment whereas, the lowest (1.10, 2.17, 2.58 and 3.00, respectively) was counted from F_0 treatment. The highest transpiration rate (0.43, 0.94, 1.27 and 1.47, respectively) was recorded from foliar spray with Kaolin and CCC (F_3) treatment whereas, the lowest (0.22, 0.58, 0.76 and 0.98, respectively) was counted from foliar spray with water (F_0) treatment. The highest bulbs number (23.78) was observed from F_3 treatment whereas, the minimum number (19.33) was observed from F_0 treatment. The highest diameter of bulb (3.93 cm) was found from F_3 (foliar spray with Kaolin and CCC) treatment whereas, the lowest (3.26 cm) was observed from F_0 (foliar spray with water). The highest weight of bulb (152.70 g) was observed from foliar spray with Kaolin and CCC. On the other hand, the lowest weight of bulb (125.30 g) was found from foliar spray with water. The highest weight of dry bulb (38.62 g) was observed from foliar spray with Kaolin and CCC treatment. On the other hand, the lowest weight of bulb (36.02 g) was found from foliar spray with water treatment. The highest length of flowering stalk (91.00 cm) was recorded from F_0 treatment. On the other hand, the lowest length of flowering stalk (78.77 cm) was recorded from F_3 treatment. The highest length of rachis area (31.80 cm) was observed from foliar spray with water (F_0) treatment whereas, the lowest (26.33 cm) was observed from foliar spray with Kaolin and CCC (F_3) treatment. The highest spikelet per spike (50.02) was obtained from the foliar spray with Kaolin & CCC whereas, the lowest (40.41) was recorded in the foliar spray with water.

Due to the significant interaction effects of moisture regime and application of kaolin and CCC on plant height, the tallest plant (63.00, 67.25, 72.12 and 74.98 cm, respectively) was obtained from I_0F_0 treatment whereas, the shortest plant (52.34, 55.26, 59.38 and 62.20 cm, respectively) was obtained from I_2F_3 treatment. Due to the interaction of irrigation and plant growth substance on the total numbers of leaves plant^{-1} at 80, 100, 120 and 140 DAP, the maximum number of leaves plant^{-1} (18.00, 34.53, 46.92 and 52.70, respectively) was recorded with the combination of 100% ET irrigation and foliar spray with Kaolin & CCC (I_1F_3) treatment whereas, the minimum (12.00, 20.49, 28.88 and 33.70, respectively) was recorded from the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. Interaction effect of different irrigation regime and kaolin, CCC influenced the leaf temperature at 80, 100, 120 and 140 DAP, it was observed that the maximum (39.07^{0}C, 36.93^{0}C, 34.94^{0}C and 32.60^{0}C, respectively) was obtained from I_0F_0 treatment whereas, the minimum (35.30^{0}C, 34.20^{0}C, 31.83^{0}C and 28.27^{0}C, respectively) was recorded from I_2F_3 treatment. The highest percentage of RWC (123.6 %) was obtain from the combination of 100% ET irrigation and foliar spray with Kaolin and CCC (I_0F_3) treatment whereas, the lowest (76.70 %) with the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. The maximum chlorophyll content (SPAD value) (67.50 and 55.98 %, respectively) was recorded from the combination of 100% ET irrigation and foliar spray with Kaolin & CCC (I_1F_3) treatment. On the other hand, the minimum chlorophyll content (SPAD value) (58.80 and 49.00 %, respectively) was recorded from the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. The highest stomatal conductance (20.60, 36.97, 57.44 and 78.60 mmol ms^{-2}, respectively) was obtained from the combination of 100% ET irrigation and foliar spray with Kaolin and CCC while, the lowest (13.70, 22.38, 29.42 and 44.00 mmol ms^{-2}, respectively) was recorded from the combination of 50% ET irrigation and foliar spray with water. CO_2 assimilation of tuberose significantly influenced by the Interaction effect of irrigation and plant growth substance at 80, 100, 120 and 140 DAP , the maximum CO_2 assimilation (2.40, 3.38, 4.74 and 5.90, respectively) was recorded from the combination of 100% ET irrigation and foliar spray with Kaolin and CCC (I_1F_3) treatment. On the other hand, the lowest CO_2 assimilation (1.00, 1.53, 2.11 and 3.20, respectively) was recorded from the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. The maximum evaporation rate (0.56, 1.06, 1.49 and 1.91, respectively) was recorded from the combination of 100% ET irrigation and foliar spray with Kaolin and CCC (I_0F_3) treatment. On the other hand, the lowest transpiration rate (0.18, 0.30, 0.66 and 0.71, respectively) was recorded from the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. The maximum number of bulbs (25.67) was recorded with the combination of 75% ET irrigation and foliar spray with Kaolin & CCC (I_1F_3) treatment whereas, the minimum (16.00) was recorded from the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment. The maximum diameter of bulb (4.40 cm) was recorded from the treatment combination of I_1F_3 treatment whereas, the minimum diameter of bulb (3.20 cm) was recorded from I_1F_2 treatment. The maximum weight of bulb (194.00 g) was observed in I_1F_3 treatment (75% ET irrigation and foliar spray with Kaolin and CCC) whereas, the minimum (70.00 g) was observed from I_2F_0 treatment. The maximum weight of bulb (43.70 g) was observed in I_1F_3 (75% ET irrigation and foliar spray with Kaolin and CCC) treatment whereas, the minimum (32.30 g) was observed from I_2F_0 (50% ET irrigation and foliar spray with water) treatment. The maximum length of flowering stalk (103.00 cm) was recorded from the combination of 100% ET irrigation and foliar spray with water treatment whereas, the minimum (71.70 cm) was recorded from the combination of 50% ET irrigation and foliar spray with kaolin and CCC (I_2F_3) treatment. The maximum length of rachis (38.70 cm) was recorded with the combination of 100% ET irrigation and foliar spray with water (I_0F_0) treatment whereas, the minimum (21.00 cm) was recorded from the combination of 50% ET irrigation and foliar spray with Kaolin & CCC (I_2F_3) treatment. The highest spikelet per spike (60.00) was obtain from the combination of 100% ET irrigation and foliar spray with Kaolin and CCC (I_0F_3)

treatment whereas, the lowest (29.00) with the combination of 50% ET irrigation and foliar spray with water (I_2F_0) treatment.

CONCLUSION:

Considering the findings of the experiment, it may be concluded that:

1. Application of anti-transpirant kaolin and CCC were found to enhance all parameters in plants subjected to mild water stress (75% ET), while at higher stress (50%ET) anti-transpirant could not induce suitable physiological performance.
2. At mild water stress (75% ET) plant growth and flowering parameters are not negatively affected but at severe stress (50% ET) growth and flowering are negatively affected.
3. In addition to I_0F_3(100% irrigation and foliar application of kaolin and CCC) the treatment combination of I_1F_3 (irrigation 75% ET and foliar application of kaolin and CCC) showed better performance.
4. Further studies at different agro-ecological zone of Bangladesh are needed for precise recommendation.

REFERENCES

Abou L. B., Gaballah, M.S., El-Zeing, H.A. and Khalid, S. (2007). The effect of antitranspirant application on yield and fatty acids of sesame cultivars grown under saline conditions. *J. Appl. Sci. Res.* **3**(9): 879-885.

Al-Humaid, A.I. and Moftah, A.E. (2005). "Effects of Kaolin and Pinolene Film-forming Polymers on Stomatal Behavior, Water Relations, Photosynthetic Rate, and Water Use Efficiency of Tuberose (*Polianthestuberosa*L.) Plants Grown under Water Deficit Conditions". *J. King Saud Univ. Agric. Sci.* **18**(1): 35-49.

Biswas I., Bose T.K., Maity, R.G. (1983). Effect of growth substances on growth and flowering of tuberose (*Polianthestuberosa*L.) *South Indian Hort.* **31**: 129-132.

Choudhury, S. and Gupta, K. (1996). Effect of CCC on growth and alkaloid production in *Catharanthusroseus*L. G. Don. *Indian J. of Physio.*,**1**(3): 163-167.

Delperee C., Kinet J. M., Lutts S., (2003). Low irradiance modifies the effect of water stress on survival and growth related parameters during the early developmental stages of buckwheat (*Fagopyrum esculentrum*). Physio. Plant. 119: 211-220.

Fereres E., Soriano M. A., (2007). Deficit irrigation for reducing agricultural water use. *J. Exp. Bot.*, 58: 147-159.

Fetouh M.I. and Hassan, F.A.S, (2014).Water relations, growth and flowering of *Strelitziareginae*Ait as affected by different irrigation treatments. Int. J. Adv. Res., Volume **2,** Issue 2, 906-912.

Gehan H., Abdel-Fattah ,(2013). Response of water-stressed rose of China (*Hibiscus rosa-sinensis*L.) plant to treatment with calcium carbonate and vapor gard antitranspirants. *J. Appli. Sci. Res*. **9**(6): 3566-3572.

Glenn, D. M., Cooley, N. , Walker, R. , Clingeleffer, P. and Shellie, K. (2010)."Impact of Kaolin Particle Film and Water Deficit on Wine Grape Water Use Efficiency and Plant Water Relation," *Hort. Sci.,* Vol. **45**, No. 8, 2010, pp. 1178-1187.

Glenn, D.M., Erez, A., Puterka, G.J. and Gundrum, P, (2003). "Particle Films Affect Carbon Assimilation and Yield in Empire Apple".*J. Amer. Soc. Hort. Sci.*, **128**, 356-362.

Grewal, H.S., Kolar, J.S., Cheema, S.S. and Singh, G. (1993). Studies on the use of growth regulators in relation to nitrogen for enhancing sink capacity and yield of gobhi- sarson (*Brassica napus). Indian J. Plant Physio.*, **36**(I): 1-4.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedure for Agricultural Research (2nd edn.). Int. Rice Res. Inst., A willey Int. Sci., pp. 28-192.

Halepyati, A.S., Sujatha, K. and Prabhakar, M.M. (1996). Growth, yield, water relations and its use in tuberose (Polianthestuberosa) as influenced by irrigation regime and nitrogen level .*Ind. J. Agric. Sci.*, **65**(12): 866-869.

Hassan, F.A.S. and Ali, E.F., (2013). Impact of different water regimes based on class-A pan on growth, yield and oil content of Coriandrumsativum L. plant. *J. Saudi Soc. Agric. Sci.* In Press.

Hassanein, M.M. and N.D. Manoly,(2004).Effect of growth retardants and bio-fertilization treatments on growth, flowering and chemical composition of *Dahlia pinnata*grown in sandy soil. Inter. Conf. on Micro and Biotech, in favour of Man and Environ. In Africa and Arab Region. Mansoura Univ., pp: 253-272.

Ibrahim, E.A. and E.M. Selim, (2007).Effect of irrigation intervals and nitrogen fertilizer rates on summer squash (*Cucurbitapepo*l.) growth, yield, nutritional status and water use efficiency. *J. Agric. Sci. Mansoura Univ*., **32** (12):10333-10345.

J. L. Jifon and J. P. Syvertsen, (2003). "Kaolin Particle Film Applications Can Increase Photosynthesis and Water Use Efficiency of 'Ruby Red' Grapefruit Leaves,". *J. American Society for Hort. Sci.*, Vol. **128**, No.

K. Nahar and S. M. Ullah, (2012). Morphological and physiological characters of tomato (*Lycopersiconesculentum*Mill) cultivars under water stress. *Bangladesh J. Agril. Res.* **37**(2): 355-360.

Koksal A., Ismail H. T., and Dursun B., (2011). The effects of different irrigation levels on flowering and flower quality of carnation (*Dianthus caryophllus L.)*irrigated by drip irrigation. *African J. Biotech*. Vol. 10(66), pp: 14826-14835.

Liang, Z., Zhang, F., Shao, M. and Zhang, J.,(2002).“The Relations of Stomata Conductance, Water Consumption, Growth Rate to Leaf Water Potential during Soil Drying and Rewatering Cycle of Wheat (*Triticumaestivum*).” Bot. Bull. Acad. Sin., **43**, 187-192.

Lone, N.A., Khan, N.A., and Rizwan Rashid, (2010). Effect of chlorocholine chloride on plant growth and development. Int. J. of Current Res., Vol. **6**, pp.001-007.

Lone, N.A., 2001. Studies on effect of cycocel and ethrel in association with nitrogen on growth and metabolism of mustard under non-irrigated conditions. Ph.D. Thesis, Aligarh Muslim University.

Metwally S.A.,Khalid K.A., Abou-Leila BH.,(2013). Effect of water regime on the growth, flower yield, essential oil and proline contents of Calendula officinalis. *Nusantara Biosci*., **5**: 65-69.

Mina J. , Mehdi T. , Abdollaih M. B.,(2013). Effect of antitranspirants application on yield and yield components in soybean (*Glycine max L*.) under limited irrigation. J. of Appli. Bio. Sci., **7** (1): 70-74.

Moftah, A.E.,(1997). “The Response of Soybean Plants Grown under Different Water Regimes to Antitranspirant Applications.” *Ann. Agric. Sci.*, **35**, 263-292.

Prakash M., and R amachandran K., (2000). Effects of chemical ameliorants in brinjal (Solanum melongena L.) under moisture stress conditions. *J. Agron. Crop Sci*. 185: 237-239.

Singh P. and Desai J.R.,(2013). Growth and flowering response to GA3 and CCC concentration in tuberose cv. Single. *Floriculture Res. Scheme, Regional Hort. Res. Station, Navsari Agricultural University*.

Shamim, F., Farooq, K., and Waheed, A., (2014). Effect of different water regimes on biometric traits of some tolerant and sensitive tomato genotypes. *J. Animal & Plant Sci.,* **24**(4), Page: 1178-118.

Rademacher, W. and Jung, J., (1989). GA biosynthesis inhibitors. *Proceedings of Plant Growth Regulators Society of America*, **13**: 102.

Rademacher, W and Jung, J.,(1986). GA biosynthesis inhibitors: an update. Proceedings of Plant Growth Regulators Society of America, **13**: 102.

Ragaa A. Taha, (2012). Effect of Some Growth Regulators on Growth, Flowering,Bulb Productivity and Chemical Composition of Iris Plants. *J. Hort. Sci. Orname. Plant.* **4** (2): 215-220.

Ramesh K., Nazeer Ahmed, Singh D.B., Om C. S., Shiv Lal and MuzamilSalmani,(2013).Enhancing blooming period and propagation coefficient of tulip (Tulipagesneriana L.) using growth regulators. *African J. of Biotech*. Vol. **12**(2), pp. 168-174.

Reddy B, Singh K, Gangadharappa PM, (1997) .Effect of growth substances on flowering and shelf life of flowers of tuberose cv. Double.*Karnataka J. Agric. Sci.* 10(3), 731-737.

Reddy, S.; Singh, K. and Gangdharappa, P.M. (1997).Effect of growth substances on flowering and shelf life of flowers of tuberose cv. Double. Karnataka *J. Agril. Sci.,* **10** (3): 737.

Slawinska, J. and Obendorf, R.L., (2001). "Buckwheat Seed Set in Plant and during *in vitro* Inflorescence Culture: Evaluation of Temperature and Water Deficit Stress". *Seed Sci*. *Res*., **11**, 223-233.

Singh, K., Vyas, M.D., Sing, P.P., Thakre, D.C. and Neme, D.P., (1988). Effect of irrigation and fertility levels on lentil.*LENS Newsletter* **15**(2): 7-9.

Sharifuzzaman S.M., Ara K.A., Rahman M.H., Kabir Kand Talukdar, M.B., (2011). Effect of GA_3, CCC and MH on vegetative growth, flower yield and quality of chrysanthemum.*Int. J. Expt. Agric*. **2**(1):17-20.

Taiz, L. and Zeiger, E.,(2002).“Stress Physiology” In: *Plant Physiology*, 3rd ed., Sunderland, Massachusetts, USA: Sinauer Assoc. Inc. Pub., , 591-620.

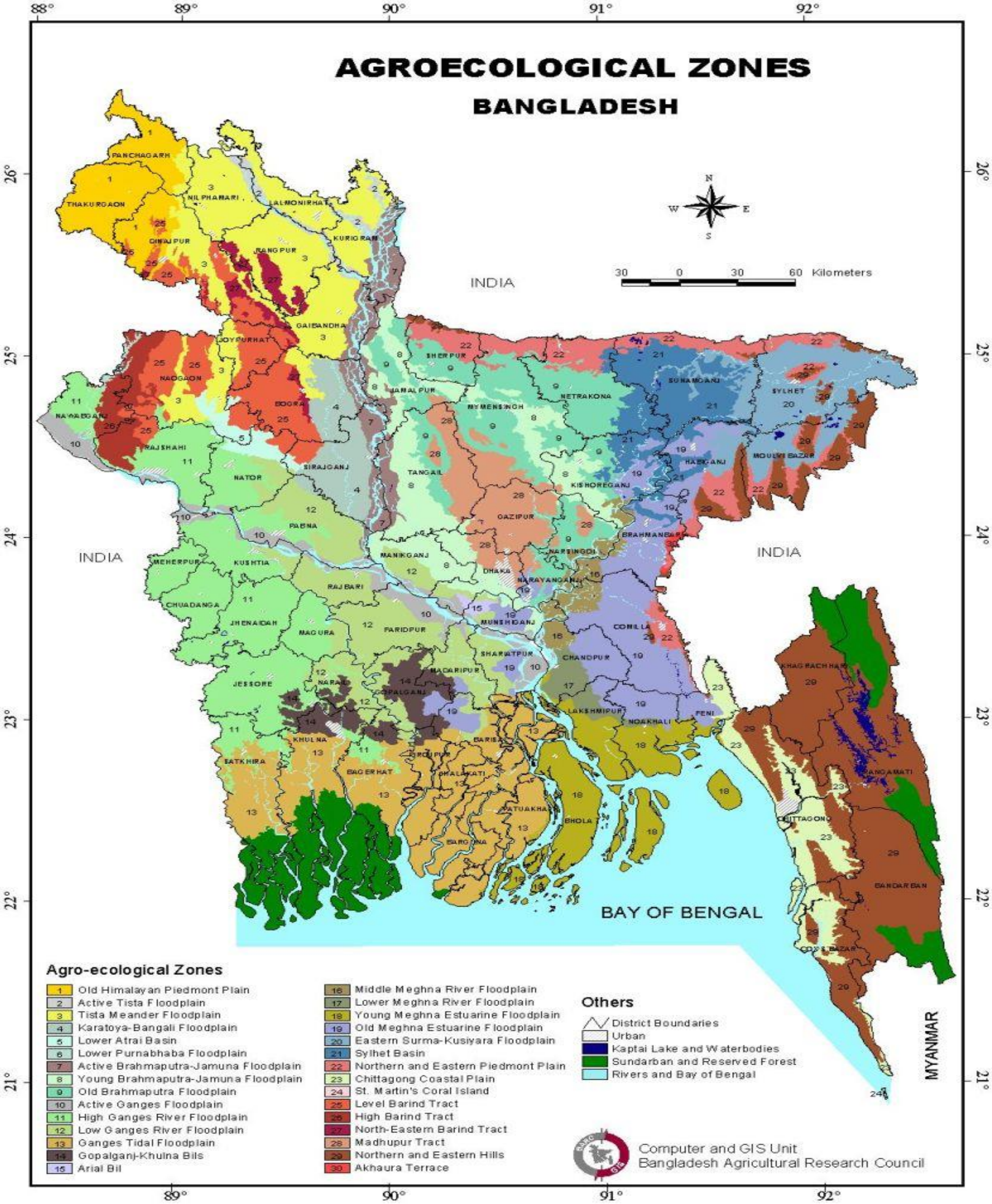
V. Cantore, B. Pace and R. Albrizio.,(2009)."Kaolin-based particle film technology affects tomato physiology, yield and quality". Environmental and Experimental Botany, **66** : 279–288.

Younis, M.E., El-Shahaby, O.A., Abo-Hamed, S.A. and Ibrahim, A.H., (2000). “Effects of Water Stress on Growth, Pigments and CO2 Assimilation in Three Sorghum Cultivars.”*J. Agron. Crop Sci*., **185**, 73-82.

Yuly Marcela Sotelo-Cuitiva, Hermann Restrepo-Díaz, Alexandra García-Castro, Augusto Ramírez-Godoy, Victor Julio Flórez-Roncancio,(2011).Effect of Kaolin Film Particle Applications and Water Deficit on Physiological Characteristics in Rose Cut Plants (*Rose spp*L.).American J. Plant Sci., **2**, 354-358.

APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh



Appendix II. Characteristics of Agronomic Farm soil is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Horticulture Farm, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping Pattern	Fallow- Tuberose

B. Physical and chemical properties of the initial soil

Characteristics	Value
%Sand	27
%Silt	43
%clay	30
Textural class	Silty-clay
P^H	6.1
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.077
Available P (ppm)	20.00
Exchangeable K (mel 1 00 g soil)	0.10
Available S (ppm)	45

Source : SRDI, 2013

Appendix III. Monthly record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from August 2013 to November 2013

Month	Average air temperature (°C)			Average relative humidity (%)	Total rainfall (mm)	Total Sunshine per day (hrs)
	Maximum	Minimum	Mean			

April, 2013	33.7	23.8	28.81	69	185	7.8
May, 2013	36.7	20.3	28.5	70	205	7.7
June, 2013	35.4	22.5	28.95	80	577	4.2
July, 2013	36.0	24.6	30.3	83	563	3.1
August, 2013	36.0	23.6	29.8	81	319	4.0
September,2013	34.8	24.4	29.6	81	279	4.4
October, 2013	34.8	18.0	26.4	77	227	5.8
November, 2013	29.7	20.1	24.9	65	5	6.4
December, 2013	26.9	15.8	21.35	68	0	7.0
January, 2014	24.6	12.5	18.7	66	0	5.5

Source: Bangladesh Meteorological Department (Climate & weather division), Agargoan, Dhaka – 1212.

Appendix IV. Analysis of variance (mean square) of plant height at different DAP

Source of variation	Degrees of freedom	Plant height			
		80 DAP	**100 DAP**	**120 DAP**	**140 DAP**
Replication	2	5.852	0.035	4.596	80.983
Irrigation (A)	2	10.897*	4.297**	1649.548*	49.245*
Growth substance (B)	3	6.051*	6.877**	858.401**	49.026*
A×B	6	0.549**	0.230*	36.429*	3.452**
Error	22	1.305	0.040	30.629	8.520

* and ** indicate significant at 5% and 1% level of probability, respectively.

Appendix V. Analysis of variance (mean square) of number of leaves plant^{-1} at different DAP

Source of variation	Degrees of freedom	Number of leaves plant^{-1}			
		80 DAP	**100 DAP**	**120 DAP**	**140 DAP**
Replication	2	1.970	16.115	0.014	41.200
Irrigation (A)	2	50.408*	39.874*	11.172**	119.856*
Growth substance (B)	3	9.672*	65.472**	11.431*	26.023*
A×B	6	0.577*	0.450**	0.617*	6.475*
Error	22	2.327	1.503	0.024	13.856

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix VI. Analysis of variance (mean square) of leaf temperature at different DAP

Source of variation	Degrees of freedom	Leaf temperature at			
		80 DAP	100 DAP	120 DAP	140 DAP
Replication	2	4.596	1381.356	8.038	7342.477
Irrigation (A)	2	1649.548*	772717.850**	82.572*	18447024.473^{NS}
Growth substance (B)	3	858.401**	2061350.604**	43.932**	11322008.251^{NS}
A×B	6	36.429*	183150.522**	0.806**	783990.010**
Error	22	30.629	404.774	3.561	1514.655

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix VII. Analysis of variance (mean square) of relative water content

Source of variation	Degrees of freedom	Relative water content	Number of spike per plant
Replication	2	0.030	0.043
Irrigation (A)	2	0.362*	0.533*
Growth substance (B)	3	0.040*	0.213*
A×B	6	0.007*	0.070*
Error	22	0.017	0.039

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix VIII. Analysis of variance (mean square) of chlorophyll content

Source of variation	Degrees of freedom	Chlorophyll content	
		80 DAP	140 DAP
Replication	2	0.014	1.567
Irrigation (A)	2	23.808**	15.230**
Growth substance (B)	3	10.162**	21.646*
A×B	6	0.499**	0.625*
Error	22	0.015	2.261

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix IX. Analysis of variance (mean square) of CO_2 assimilation at different DAP

Source of variation	Degrees of freedom	CO_2 assimilation at			
		80 DAP	100 DAP	120 DAP	140 DAP
Replication	2	4.596	1381.356	8.038	7342.477
Irrigation (A)	2	1649.548*	772717.850**	82.572*	18447024.473^{NS}
Growth substance (B)	3	858.401**	2061350.604**	43.932**	11322008.251^{NS}
A×B	6	36.429*	183150.522**	0.806**	783990.010**
Error	22	30.629	404.774	3.561	1514.655

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix X. Analysis of variance (mean square) of transpiration rate at different DAP

Source of variation	Degrees of freedom	Evaporation rate at			
		80 DAP	100 DAP	120 DAP	140 DAP
Replication	2	0.001	0.001	0.003	0.014
Irrigation (A)	2	0.016**	0.027**	0.097**	0.075**
Growth substance (B)	3	0.038**	0.018**	0.074**	0.099**
A×B	6	0.014**	0.002**	0.003**	0.001**
Error	22	0.001	0.000	0.014	0.008

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix XI. Analysis of variance (mean square) of bulb parameter

Source of variation	Degrees of freedom	Bulb dry weight	Number of bulb	Weight of bulb	Diameter of bulb
Replication	2	0.035	7.068	10.423	73.426
Irrigation (A)	2	4.297**	334.201**	339.464**	411.886*
Growth substance (B)	3	6.877**	901.727**	751.181**	290.585*
A×B	6	0.230*	5.313**	29.688*	25.105*
Error	22	0.040	10.383	18.235	26.726

* and ** indicate significant at 5% and 1% level of probability, respectively

Appendix XII. Analysis of variance (mean square) of length of flowering stalk and length of rachis

Source of variation	Degrees of freedom	Length of flowering stalk	Length of rachis area
Replication	2	0.014	0.422
Irrigation (A)	2	23.808**	30.884**
Growth substance (B)	3	10.162**	16.237**
A×B	6	0.499**	0.777*
Error	22	0.015	0.422

* and ** indicate significant at 5% and 1% level of probability, respectively