INFLUENCE OF THIOUREA CONCENTRATIONS AND APPLICATION FREQUENCY ON GROWTH AND YIELD OF LIGHT PINK LISIANTHUS

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He created the heavens and earth in truth and formed you and perfected your forms; and to Him is the [final] destination" (Quran 64:3)

DEDICATED TO-

MY BELOVED PARENTS

Who offered unconditional love, support and have always been there for me

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CERTIFICATE

This is to certify that the thesis entitled ***"INFLUENCE OF THIOUREA CONCENTRATIONS AND APPLICATION FREQUENCY ON GROWTH AND YIELD OF LIGHT PINK LISIANTHUS"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirement for the degree of* ***MASTER OF SCIENCE IN HORTICULTURE****, embodies the result of a piece of bonafide research work carried out by* ***MAISHA MALIHA****, Registration No.****18-09269*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

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- Author

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ABSTRACT

An experiment was accomplished in the Horticulture farm Sher-e-Bangla Agricultural University, Dhaka during the period from November 2018- May 2019 to study the influence of thiourea concentrations and application frequency on growth and yield of light pink lisianthus (*Eustoma grandiflorum).* Thiourea concentrations *viz*., C_1: 500 ppm, C_2:1000 ppm, C_3:1500 ppm and application frequency, T_0: Control: No thiourea application, T_1: single application, T_2: twice application were used in this experiment arranged in a Randomized Complete Block Design with three replications. Data on growth, physiology, yield and quality attributes parameters were taken in which all the treatments showed significant variations. Among thiourea concentrations, maximum plant height (59.6 cm), stem number/plant (4.4), flower/plant (26.6), maximum chlorophyll content (56.6), flower head diameter (6.3 cm), yield/plot (793.2) were recorded from C_3 and for application frequency, the longest Stem (47.3 cm), peduncle length (12.7 cm), maximum stem diameter (4.3 mm), flower per plot (898.3) in twice application (T_2). Furthermore maximum flower yield per plant (37.3) and yield per plot (1116.7) were found in C_3T_2 and minimum yield per plant (10.3), yield per plot (309.7) in C_0T_0. In view of overall observations, twice application of thiourea at 1500 ppm concentrations had showed the best result and would be the potential for increasing the lisianthus flower production.

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ABBREVIATIONS AND ACCORONYMS

AEZ	=	Agro-ecological Zone
Agric.	=	Agricultural
ANOVA	=	Analysis of Variance
BARI	=	Bangladesh Agricultural Research Institute
Biol.	=	Biology
Cv	=	Coefficient of variance
DAP	=	Days after planting
et al.	=	And others
Ex.	=	Experiment
g	=	Gram
Hort.	=	Horticulture
i.e.	=	That is
J.	=	Journal
Kg	=	Kilogram
LSD	=	Least Significance difference
mm	=	Millimeter
RCBD	=	Randomized Complete Blocked Design
Res.	=	Research
SAU	=	Sher-e-Bangla Agricultural University
Sci.	=	Science
spp.	=	Species
Technol.	=	Technology
Viz.	=	Namely

CHAPTER I

INTRODUCTION

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Lisianthus *(Eustoma grandiflorum*), Bengali name: Nandini belongs to the family Gentianaceae, is an ornamental cut-flower native to the southern parts of united states particularly to the eastern slope of Rocky Mountains, USA where it is known as the prairies gentian .It is also known as *Eustoma*, Texas Blue bell, Tulip gentian etc. *Eustoma* is named after the two Greek words Eu (beautiful, good, well), and stoma (mouth). It is a moderately cold-tolerant annual or biennial plant .It is a slow growing plant, requiring 5 to 6 months from sowing to flowering.

Foliar feeding is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Plants are able to absorb essential elements through their leaves. The absorption takes place through their stomata and also through their epidermis. Foliar feeding, however, can be a very effective way of supplementing nutrients in the short-term. Studies have shown that foliar feeding is as much as 95% effective. This means plants take in almost all nutrients administered by spray, while they uptake a smaller percentage when fed through the soil. Foliar application of nutrients is gaining more importance in fertilization of various field and floricultural crops, in many countries. The advantages of foliar fertilizers were more obvious under growing conditions restricting the absorption of nutrients from the soil, as reported by Verma et al., (2017). Foliar spraying with zinc (100 ppm) in blue sage (*Salvia farinacea L.)* enhanced the length of peduncle, length of main inflorescence, number of inflorescence and florets, and fresh and dry weight of inflorescences/ plant (Nahed and Balbaa, 2007). The superiority of the foliar application of nitrogen over soil application increased the productivity, quality, and profitability of wheat (Nazia Baloch *et. al.*, 2019)

Thiourea is an organosulfur compound with the formula $SC(NH_2)_2$. Thiourea enhances the tolerance against stress because of its high water solubility and quick absorption in living tissues. Among the stress alleviating compounds, thiourea is an important molecule with two functional groups; 'thiol' is important to oxidative stress response and 'imino' partly fulfils the N requirement. It is highly water soluble and easily absorbed in the living tissues. It is structurally similar to urea, except that the oxygen atom is replaced by a sulfur atom, but the properties of urea and thiourea differ significantly. Thiourea is a reagent in organic synthesis. Thiourea also believed to delay the leaf aging and senescence in plants (Garg *et al*.,2006). Some other studies have reported that thiourea can be a potential compound to improve the photosynthetic efficiency , growth and yield of crops (Sahu *et al.,* 1993.Anitha *et al*.,2004). Thiourea stimulates dark fixation of CO_2 in embryonic axes of chickpea (Hernandez-Nistal *et al.* 1983; Amin *et al.*,2014) also reported that foliar feeding of thiourea significantly increased the growth related parameters of faba bean. Because of the -SH group, thiourea may play several bioregulatory roles in crop plants, as the -SH group has diverse biological activities .Thiourea has been reported to significantly improve growth, yield and water use efficiency of wheat (Sahu and Singh 1995), and on clusterbean (Garg *et al*., 2006) under arid and semiarid conditions. In the present study, therefore, a sulfhydryl compound, thiourea was tested with a view to improving the productivity crops and timely supplying of growth regulators as externally as foliar application at proper crop growth stage with optimum concentration and frequency could play a prominent role in increasing crop yield and quality of produce in different crops (Nagasubramaniam *et al.*, 2007).

Folier application of thiourea at different application frequencies also shows significant variations in growth and quality of crops and flowers. Variations in plant height, leaves no., branch no., flowering ,seed settings etc. observed in chickpea at twice application (50 and 80 DAS) compared to control . (Abhishek, *et al*.,2019)

Lisianthus is a newcomer in Bangladesh that has the advantage of striking bloom with great appeal and it has a great demand on commercial flower market in Bangladesh and also in other countries. Keeping in view the potential of lisianthus nationally and internationally, the present study was planned to evaluate the effect of folier application of thiourea on growth, physiology, yield and quality related parameters of lisianthus. The aim of this work was to evaluate the influence of different concentrations and application frequencies of thiourea on lisianthus production.

OBJECTIVES:

Considering the above facts this experiment was undertaken with following objectives

1. To study the different concentrations of thiourea on light pink lisianthus
2. To study the application frequency of thiourea
3. To find the optimum level of thiourea concentrations and application frequency on light pink lisianthus flower

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

An experiment was conducted to evaluate the effects of foliar application of Thiourea at different concentrations and applications frequencies on physiology, flower quality and yield of lisianthus flower. Results showed that foliar application of thiourea at 1500 ppm and twice application at 20 and 45 days after transplanting the plant growth significantly increased the physiological attributes viz., plant height ,branch number , leaf number, stem length , flower number, flower quality compared to other treatments.

Uddin, *et.al.(*2020) conducted an experiment at the horticultural farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during April-July 2019 to study the potentiality of thiourea application frequency for enhancing the okra production. The experiment conducted with four treatments, viz., No application (TU_0),once application-1000 ppm (TU_1), twice application-1000 ppm (TU_2) and thrice application-1000ppm (TU_3) following Randomized Complete Block Design (RCBD) with three replications. Data on different growth and yield attributes parameters were taken in this experiment. Among them, (TU_3) showed the highest plant height (131.5 cm), maximum SPAD value (54.3) and influenced to increase the yield (25.5%) over control. In view of overall performances, thrice application of thiourea has potentiality for okra production.

Abhishek *et.al.*(2020) conducted an experiment at the Zonal Agricultural Research Station, Kalaburgi, University of Agricultural Sciences, Raichur to study the influence of foliar spray of thiourea, salicylic acid and homobrassinolide on crop growth and seed yield of chickpea (Cicer arietinum L.) under moisture stress conditions in rabi 2018-19. The experiment consisted of sixteen treatment combinations (four moisture stress with four foliar sprays) which was laid out in 2 factor RBD. Among the different treatments imposed,

two foliar spray of thiourea @ 1000 ppm under no moisture stress (control) during flowering (45 DAS) and seed setting (75 DAS) recorded significantly higher plant height (42.0 and 49.0 cm), leaf area index (3.020 and 2.003), number of primary branches plant^{-1} (9.1 and 10.7), chlorophyll content (SPAD values 64.4 and 56.6), number of pods plant^{-1} (64.3), 100 seed weight (25.0 g), drought tolerant efficiency (100%), seed yield plant^{-1} (18.9 g) and hectare^{-1} (27.2 q) compared to other treatments.

Rajan *et. al.* (2019) was carried out an investigation to study the effect of nitrogen and phosphorus on growth, flowering and yield of cut chrysanthemum cv. Thai Chen Queen. The experiment was laid out in randomized block design (RBD) with factorial concept comprising of twelve treatment combinations with four levels of nitrogen, *viz.*, 100 kg N/ha (N_1), 150 kg N/ha (N_2), 200 kg N/ha (N3) and 250 kg N/ha (N4) and three levels of phosphorus, *viz.*, 50 kg P_2O_5/ha (P_1), 75 kg P_2O_5/ha (P_2) and 100 kg P_2O_5/ha (P_3). The treatments were replicated four times. The results indicated that application of 200 kg N/ha (N_3) to cut chrysanthemum was most effective to increase plant height whereas, plants receiving 150 kg N/ha significantly improved vegetative growth as well as quality and yield of flowers. Application of 75 kg P_2O_5/ha was found promising for growth, quality as well as yield parameters.

Saleem *et.al*. (2019) conducted a field experiment to observe the effects of sulphur on sunflower growth, oil content and yield. The sulphur rates were 0, 5, 10, 15, and 20 kg ha^{-1}. The recomended rates of nitrogen, phosphorus and potasium were given to all plots of different treatments. The economical important plant growth parameters ; height of plant (cm), stem girth, diameter of flower disk (cm), quantity of achenes (head^{-1}), weight of 1000 achenes, oil (%) in achene, yield (ha-1), and sulphur content (%) in plant straw were evaluated. The values among the treatments for higher plant height (161.80 cm), wide stem girth (4.80 cm), flower head diameter (15.40 cm), maximum number of achene head-1 (787), weight of 1000 achenes (50.29 g), higher grain yield ha^{-1} (650.33 kg), oil content % (42.20), achene yield plant^{-1} (39.57 g) and

sulphur content % of plant straw (0.225) were recorded when sulpher rate at 20 kg ha-1 were applied to crop. These values were significantly higher compared to other S levels of 5, 10 and 15 kg ha^{-1}. The outcome of experiment had revealed that with the increasing level of S, the sunflower plant growth and yield attributes were significantly improved. The application of sulphur at 20 kg ha-1 was superior in enhancing overall growth, achene yield and oil content % of sunflower.

Uddin. *et.al.* (2019) conducted a field experiment that was accomplished in the Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka during the period from Jun 2019 – mid August 2019 to study the efficacy of Thiourea application on Garlic chives production. Thiourea applications, viz., No application (TU_0), once application-1000ppm (TU_1) and Twice application-1000ppm (TU_2) were used in this experiment arranged Randomized Complete Block Design with three replications. Data on different growth and yield attributes parameters were taken in which all the treatment showed significant variations. Maximum yield/plant (15.0 g, 17.7 g and 19.3 g), yield/plot (428.0 g, 531.3 g and 579.7 g) and yield/ha (13.86 t) found in twice application of thiourea treatment (TU_2). In view of overall performances, twice application (TU_2) of thiourea has potentiality for Garlic chives production.

Baloch *et.al.* (2019) was conducted a field experimen to investigate the effect of foliar application of nitrogen on growth, yield and grain quality parameters of wheat (Triticum aestivum L.) (cv.'TD^{-1}). The thrice replicated treatments included T1: Recommended dose of NPK (168:84:60 kg ha-1), T_2= Full Recommended dose of 168 kg ha^{-1} N+ 0.5% N foliar spray)T_3= Half Recommended dose 84 kg ha^{-1} N + 0.5% N foliar spray at booting stage) T4= Full Recommended dose 168 kg ha-1 N + 1% of N foliar spray at booting stage),T_5= Half Recommended dose of 84 kg ha-1 N + 1% N foliar spray at booting stage. All the treatments also received a recommended blanket dose of P (84 kg ha-1) and K (60 kg ha^{-1}), through soil mixing of DAP and SOP before wheat sowing. The soil application of 84 kg N ha^{-1}, in all the treatments, was

done through broadcasting at the time of first irrigation. In T_1, T_2, T_4 the remaining 84 kg N ha-1 has applied at the time of ear head emergence (EHE). The foliar application of urea was done at booting stage. The experimental soil was heavy, non-saline, alkaline, and low in organic matter and P, with adequate K. The results revealed that the plant height at maturity, number of tillers, spike length, Spike length (cm), Grains spike -1 and Grain yield (kg ha^{-1}), were remained non-significant ($p > 0.05$). Nonetheless, except for HI, T_4 and T_5 remained superior ($p < 0.05$) over both T_1, T_2 and T_3. The maximum significant ($p < 0.05$) DW was found at T_4. The protein content (%), grain starch (%) and seed moisture (%) of grain were also superior ($p < 0.05$) in the case of T_4.

Pawar *et al.*, (2018) conducted the experiment to entitled "Effect of thiourea and salicylic acid on growth, flowering and yield of gladiolus" was carried out at Floriculture Unit, Horticulture section, College of Agriculture, Nagpur (M.S.) from October, 2017 to April, 2018 with nine treatment combinations in Randomised Block Design. The treatments comprised of different concentration of thiourea and salicylic acid viz., T_1– Thiourea 1%, T_2 – Thiourea 2%, T_3 – Salicylic acid 100 ppm, T_4 – Salicylic acid 150 ppm, T_5 – Thiourea 1% + Salicylic acid 100 ppm, T_6 – Thiourea 2% + Salicylic acid 100 ppm, T_7 – Thiourea 1% + Salicylic acid 150 ppm, T_8 – Thiourea 2% + Salicylic acid 150 ppm and T_9 – Control. The results revealed that, significantly minimum days for sprouting of corms, maximum sprouting percentage of corms, plant height, leaf area, flowering span, spikes plant-1, length of spike and florets spike-1 were registered with the plants treated with Thiourea 1% + Salicylic acid 150 ppm which was closely followed by Salicylic acid 150 ppm and 50 per cent flowering was recorded earliest with the treatment of Salicylic acid 150 ppm.

Premaradhya N. (2018) was Conducted the experiment to study the effect of sulphydryl bio-regulator like thiourea through foliar application on growth, yield and profitability of lentil in rice fallows. The experiment was laid out in randomized block design and replicated thrice with thirteen treatments

including water spray (control), 2% urea, 500 ppm and 1000ppm thiourea at different stages of crop growth. Results revealed that application of thiourea @ 1000ppm at pre-flowering and pod initiation recorded significantly increased shoot length (34.1cm), total dry matter (19.52 g plant-^{1}), number of pods plant-1 (73.8) and thereby enhanced grain yield (15.9 q ha^{-1}), straw yield (33.0 q ha-1) and protein yield (325.4 kg ha^{-1}) followed by recorded higher total nitrogen (106.78 kg ha^{-1}), phosphorus (24.06 kg ha-1), potassium (63.48 kg ha-1) and sulphur (6.74 mg kg soil^{-1}) uptake. Moreover, this method of providing growth promoters and nutrients directly to metabolic sites (leaves) at critical stages fetched higher net returns (Rs. 53055 ha-1) and yielded B: C ratio (2.95) over other treatments and control. The mean seed yield (74.4%) in the above treatment was significantly higher compared to the control (no spray) and low dose of spray (500 ppm). Hence, foliar application of thiourea at 1000ppm at pre flowering and pod initiation is promising and profitable for economical lentil production by resource poor farmers of NEH Region.

Zain *et al*.(2017) conducted a field study to estimate the potential of thiourea for enhancing the performance of late sown wheat. Wheat cultivar, Glaxy 2013 was sown in mid-December, 2014-15 and two foliar treatments i.e. 300 and 600 mg/L of thiourea solutions applied at different developmental stages i.e. tillering, jointing and booting, while, water spray and no spray were considered as double control. Growth characteristics of wheat were significantly enhanced with the foliar application of thiourea at tillering stage @ 300 mg/L. Likely, yield contributing traits as number of productive tillers, number of grains per spike, 1000-grain weight and grain yield were considerably improved by the application of 300 mg/L of thiourea at tillering stage. It was concluded that at tillering stage the application of thiourea (at 300 mg/L) was highly effective in improving the growth and yield of late sown wheat.

Sher *et.al.*(2017) conducted an experiment to evaluate the impact of foliage applied thiourea on the performance of four safflower genotype viz. 16427 ,16493,26733, and 26748 .Thiourea as foliage applied to all genotype at 250,

500, 750, and 1000 ppm; no thiourea application being taken as control .Result indicated that folier application ofthiourea significantly improved the crop growth rate , stay green, plant height ,number of branches ,pod per plant , number of seed per pod ,1000 seed eight ,biological and seed yield and oil quality of all safflower genotype .Among the various concentrations of thiourea folier application at 1000 mg L asmost effective for improvement in crop groth rate , morphological and yield related parameters and the oil quality . Among different safflower genotype the highest seed yield is recorded in 16493 genotypes .In crux folier application of thiourea at 1000 mg /L might be opted to improve the performance ((yield andquality) of safflower.

Verma *et al*. (2017) was conducted a field experiment to study the effect of thiourea and zinc on quality and economics of cauliflower (Brassica oleracea var. botrytis L.) variety Snowball-16 during Rabi season of 2015-16 at Horticulture Farm, S.K.N. College of Agriculture, Jobner. The experiment consisted of sixteen treatment combinations with four levels of thiourea (Control, 500 ppm, 750 ppm and 1000 ppm) and four levels of zinc (Control, 2.5, 5.0 and 7.5 kg/ha) in randomized block design with three replications. The results indicated that application 1000 ppm thiourea significantly increased NPK and Zn content and ascorbic acid and protein content in curd of cauliflower. Although, application of 750 ppm thiourea was found statistically at par to 1000 ppm thiourea. Similarly, application of zinc 7.5 kg/ha significantly increased all the quality parameters of cauliflower, but it was found statistically at with zinc 5.0 kg/ha for quality attributes. The interactive effect of 1000 ppm thiourea along with 7.5 kg/ha zinc, being statistically at par to application of 1000 ppm thiourea + 5.0 kg/ha zinc but found significantly superior with respect to maximum net returns (Rs 218077/ha) and B: C ratio (2.61).

Skudra and Ruza (2017) conducted an experiment to evaluate the Nitrogen management strategy in plant growth period based on chlorophyll content evaluation in plant can improve nitrogen usage efficiency and reduce

environmental contamination. This study is aimed to determine the impact of different nitrogen and sulphur fertilizer rates on dynamics of chlorophyll content in winter wheat during vegetative growth and to determine the relationship between nitrogen and chlorophyll content and grain yield of winter wheat. Field trial involving a winter wheat (Triticum aestivum L.) variety 'Kranich' was conducted at the LUA Research and Study Farm Vecauce during a three-year period (2012- 2015). The treatments were 0, 85, 153, 175+S21, 175 (in 2015), 187 N kg ha^{-1} and different nitrogen norms according to chlorophyll meter Yara N-tester (Konica Minolta Ltd.) data: 180, 150, 205 N kg ha-1 depending on the year. The results of the trial show that the maximum chlorophyll content in different plant parts was observed at the end of flowering stage.The highest chlorophyll content in leaves, stems and ears was obtained by using additional sulphur in two trial years. Usage of chlorophyll meter Yara N-tester obtained the highest chlorophyll content in all analyzed plant parts in one trial year. Chlorophyll content was significantly dependant on plant growth stage in stems in all trial years, in leaves in two trial years, and in ears in one year. Nitrogen fertilization significantly affected chlorophyll content in leaves and stems in one trial year. Close positive correlation was observed between grain yield and wheat plant chlorophyll content and average nitrogen concentration at the end of flowering stage in all three trial years.

Wahid *et.at. (*2017) conducted an study and reported that *Thiourea which is* also chemically named as *Thiocarbamide*, is a nitrogen and sulfur containing compound. It has three functional groups, amino, imino and thiol, each with important biological roles. Thiourea is being increasingly used to improve plant growth and productivity under normal and stressful conditions. Use of thiourea as seed priming agent, foliar spray or medium supplementation is more effective under environmental stress than under normal conditions. When used as seed pretreatment, thiourea increased the seed germination; while application as foliar spray improved the gas exchange properties and when used as medium supplementation, it improved the root growth and its proliferation. This indicates that thiourea is more effective in the tissues where

it is applied. Although to a differential extent, thiourea is effective in improving plant growth and development under drought, salinity, heat stress and heavy metal toxicity. At physiological level, it improves the leaf gas exchange, nutrient acquisition by the root and assimilation thereafter. At biochemical level, exogenously applied thiourea improves the sugar metabolism and enhances the proteins biosynthesis. At molecular level, thiourea application modulates the pattern of gene expression regardless of the stress applied. Signaling of gene expression is a likely mechanism induced by thiourea. In a nutshell, even though considerable advancement has been made in understanding the biological roles of thiourea in modulating different mechanisms in plants.

KHOKHAR *et al*. (2016) conducted this study to access the effect of thiourea on growth and productivity of rainfed wheat during 2012-14 with seven treatments of seed primingalone and in combination with foliar spray after 50 and 80 days after sowing (DAS).The physiological traits like dry matter accumulation at 60 DAS (33.8 g/m), 90 DAS (61.6 g/m) and at harvest (150 g/m), leaf area index at 60 DAS (1.57), 90 DAS (2.31) and harvest (1.01) and crop growth rate 0 to 60 DAS (0.56 g/m/day), 60 to 90 DAS (0.93 g/m/day) and 90 DAS to harvest (1.01 g/m/day) as well as the yield attributes like ear length (10.5 cm), grains/spike (40.0) and 1000-grain weight (46.8 g) were significantly higher in seed priming with 1000 ppm thiourea + spray of 1000 ppm thiourea at 50and 80DASthan other treatments. The per cent increase in yield with seed priming and foliar spray of thiourea over control ranged from 2.91 (seed priming with 1500 ppm) to 17.64 (seed priming + spray of 1000 ppm thiourea at 50DAS and 80DAS). Hence, seed priming (1000 ppm) and foliar spray (1000 ppm) of thiourea can improve the productivity of rainfed wheat under moisture stress conditions.

Amin *et.al*. (2016) conucted the field experiments which is carried out in sandy soil at El-Fayoum Governorate, Egypt, during two successive winter seasons of 2013/2014 and 2014/2015. This study aimed to investigate the response of

vegetative growth, yield, and some metabolic constituents of wheat (*Triticum aestivum* L.) cv. Sakha 93 to exogenously applied of two bioregulators i.e. Benzoic acid (BA; 100, 200 and 400 mg $^{L-1}$) and Thiourea (TU; 250, 500, and 1000 mg L^{-1}), either alone or in combination. Foliar application of BA and TU alone or in combination significant increased the tiller number and spikes/m^2, total plant dry weight/m^2, flag leaf area, blades area/plant and yield criteria (spike length, number of grains/spike, number of spike/m2, grain index, grain yield/fed, straw yield per feddan) and these effects were greater with application of BA and/or TU up to 200 and 1000 mg L^{-1}, respectively. Spraying wheat plants by BA and TU, alone or combined significantly improved the nutritional value and quality of wheat grains by increasing oil percent, crude protein, total soluble sugars and total free amino acids contents. In conclusion, the yield-contributing characters and quality of wheat could be improved by application of BA and/or TU up to 200 and 1000 mg L^{-1}, respectively.

Patel *et. al.* (2016) reported that foliar application of nutrients and Thiourea on flowering and fruiting of mango cv. Kesar was studied. Nine treatments, involving; Control, 2.0 % 00:52:34 + 0.5 % Thiourea, 2.0 % 10:52:17 + 0.5 % Thiourea, 0.5 % KNO3 + 0.5 % Thiourea, 1.0 % KNO3 + 0.5 % Thiourea, 2.0 % 00:52:34 + 1.0 % Thiourea, 2.0 % 10:52:17 + 1.0 % Thiourea, 0.5 % KNO3 + 1.0 % Thiourea and 1.0 % KNO3 + 1.0 % Thiourea were tried. The spray of nutrients was done in 15th October and Thiourea in 15th November respectively. Results revealed that foliar application of 1.0 % KNO3 in mid October followed by 1.0 % Thiourea in mid November was found best for controlling the growth of vegetative shoot (0.70) and improving flowering shoots (0.85) as well as length of flowering shoots (48.67 cm). It also increased the number of fruit set at pea (14.56 %), marble (3.15 %), maturity stage (0.87 %), numbers of fruit per tree (281.30) and yield (77.02 kg/tree). Hence foliar application of 1% KNO_3 on 15th October followed by 1 % Thiourea on 15th November resulted in minimum vegetative growth, induced early flowering with higher yield.

RAKESH and BANIK (2016) conducted a field experiment by using Indian mustard *Brassica juncea* (L.) *Czern & Coss* as a test crop with S levels (15, 20, 25,30kg ha^{-1}) each from two sources (bentonite-S and single superphosphate) to evaluate the effect on the yield parameters during rabi season of 2013-2014. Results revealed that the most of the growth parameters and yield attributes were significantly influenced by different doses of sulphur. The growth and yield parameters increased with increasing levels of sulphur up to 25 kg S ha-1 followed by reduction at higher level (30 kg S ha-1). All the growth (plant height, leaves and branches per plant) and yield parameters (siliquae per plant, seeds per siliqua, length of siliqua, 1000 seed weight) seed yield and stover yield, oil content were found maximum with 25 kg S ha-1 as SSP, which wasat par with 30kg S ha-1 as Bentonite-S. The Agronomic use efficiency of sulphur decreased with the successive addition of S in the form of both sources. Plant S uptake was maximum with 30 kg S ha^{-1} as Bentonite but it was decreased with increasing dose from 25 to 30 kg ha^{-1} as SSP. Soil available S was increased with SSP than the Bentonite-S.

Parihar *et.al*. (2016) coduct the experiment to observe the response of pearl millet to nitrogen. sulphur, and seed and foliar application of thiourea, a sulphydryl compound was studied under arid conditions for three consecutive seasons. Application of 40. 80 and 120 kg N ha'J significantly increased mean grain yield by 46.7. 72.1 and 71.7% and stover yield by 16.9. 33.1 and 38.9%. respectively. Increase in yield due to N was a cumulative effect of significant increases in yield attributes (number of ears plan (1 by 7.2-9.9%. number of grains ear'J by 11.0-27.2%. 1000-grain weight by 12.5-18.4%). Sulphur application had no significant effect on grain yield, even though the available sulphur content of the soil ranged between 8.4 to 8.9 ppm. The N:S ratio of leaves remained around 14. indicating. Presence of efficient mechanism for sulphur uptake and translocation' by the crop. Pearl millet was thus identified as S-efficient crop. Foliar spray of 1000 ppm thiourea significantly increased

yield attributes especially the lOOO-grain weight. Dry matter distribution either in leaves or stems decreased due to thiourea spray and there was commensurate increase in dry matter distribution in ears leading to enhancement in capacity of developing grains to accept carbohydrates and consequent increase in yield by 0.181 t ha over untreated control. Thiourea seed plus foliar treatment led to further improvement in grain yield.

Sable *et .al*. (2015) was undertaken an investigation to analyze the effect of foliar application of plant growth regulators on growth and flower quality of gladiolus cv.'H.B.Pitt'. In the present study it was found that the maximum height of the plant (59.43 cm), number of leaves (13.9), leaf area (64.8 cm^2) were recorded by treatment GA_3 200 ppm foliar spray. Lowest plant height was observed in treatment CCC 750 ppm spray. Minimum number of leaves/ plant (10.8) and leaf area (64.8 cm^2) were recorded in CCC 250 ppm/plant as foliar spray. In flower quality parameters, maximum number of florets/ spike (13.4), floret length (8.4 cm), length of spike (80.28 cm) and length of rachis (41.50 cm) were recorded with foliar spray of GA_3 200 ppm. Maximum weight of floret (10.1 g), diameter of floret (9.5 cm) and girth of spike (2.60 cm) were produced by CCC 750 ppm foliar spray. Minimum number of florets/spike (8.2) and floret length (7.1 cm) were recorded in CCC 250 ppm foliar spray. Lowest weight of florets (8.3 g), diameter of florets (8.2 cm) and girth of spike (1.90 cm) were recorded in GA3 100 ppm spray. Lowest length of spike (74.20 cm) and length of rachis (35.09 cm) were recorded in CCC 750 ppm foliar spray.

Padmalatha *et al*. (2014).conductd an experiment to observe the effect of thiourea (TU), salicylic acid (SA), potassium nitrate (KNO_3) and giberellic acid (GA3) with two corm soaking periods on growth, flowering and post harvest life of two gladiolus cultivars Darshan and Dhiraj was investigated during two consecutive years, 2008-09 and 2009-10. Cv. Darshan was early in flowering and performed better than the cv. Dhiraj with respect to vegetative and floral parameters. Pre-planting soaking of corms for 24 h improved vegetative and

flowering attributes. SA 150 ppm followed by TU 2% was more effective in increasing vegetative growth and reducing number of days to flowering. SA 150 ppm followed by GA_3 150 ppm were effective in improving flowering performance of gladiolus cultivars in terms of increasing number of spikes per plant, spike length and weight and number of florets per spike. Post harvest studies revealed that soaking of corms for 24 h recorded significantly less number of days to first floret opening.

Ruamrungsri, *et.al*.(2007) reported that Seedlings of Phalaenopsis hybrid, 5-month old, were planted using sphagnum moss as potting media. One month after planting, plants were used in two experiments. The first experiment was focused on the effect of three levels of nitrogen concentration, N100, N150 and N200 mg L^{-1} combined with two levels of phosphorus concentration, P50 and P100 mg L^{-1}, one flower quality and N and P concentration in leaf. It was shown that plants supplied with N200 gave better results in terms of flower stalk length, inflorescence length and number of flowers per stem than those of N100 but it was not significantly different from N150. Plants supplied with P100 gave better stem length and early flowering than those of P50. Nitrogen and phosphorus concentration in leaves increased when application of these two elements increased. However, potassium concentration in leaves was not significantly different among treatments.The second experiment was conducted using different levels of liquid fertilizer, T_1 using tap water, T_2 using 21N-$21P_2O_5$- 21K2O every 2 days and T_3 using 21N-21P2O5-21K2O every 7 days. It was found that T_2 and T_3 gave better results in terms of leaf area and leaf dry weight than those of T_1. Nitrogen concentration in leaf of T_2 was greater than that of T3 whereas concentrations of other elements, P, K, Mg, Fe, Mn and Zn, were not significantly different among treatments. However, calcium concentration in leaf of T_1 was greater than T_2 and T_3. Plants given T_2 and T_3 showed no difference and they were better than those of T_1.

Sirin (2011) was conducted this research to determine the effects of different nutrient solution formulations on the yield and quality of cut flowers and

growth of gerbera plants in substrate culture system. Five different nutrient solution formulations were used. The gerbera plantlets were planted into pots filled with perlite and peat mixture, and values of flower yield and cut flower quality criteria, and several parameters related to growth performance such as number of daughter plants, root growth criteria, plant fresh weight were obtained. The best results of cut flower yield, flower quality and plant growth were obtained from gerberas nourished by the "Çolakoğlu-2" nutrient solution formulation which consists of 150 ppm N, 31 ppm P, 234 ppm K, 30 ppm Mg, 100 ppm Ca, 15 ppm S, 8 ppm Fe, 5 ppm Mn, 1.5 ppm B, 2 ppm Cu, 3 ppm Zn and 0.2 ppm Mo. The highest flower yield was 38.67 flowers per plant in this solution. The highest value of the number of daughter plants (3.53/plant) in gerbera was determined in the "Çolakoğlu-2" nutrient solution formulation.

This experiment was conducted for studying thiourea application effect on potato minitubers dormancy breaking in Marfona cultivar in greenhouse in 2008. Thiourea in three levels as 0, 0.5, and 1% arranged in a completely randomized design in three replicates. After dormancy breaking, attributes like as days to sprouting, length of the longest sprout, and sprout number measured. Then minitubers planted in pots and days to emergence, main stem numbers, and plant height measured.Results showed that thiourea had significant effect on all attributes except of sprouts number and length of sprouts.Applying 1% thiourea decreased days to sprouting date from 102 to a bit less than 90 days, decreased days to emergence from 38 to 28 days, increased stem number from 1.2 to 2.1, increased plant height at least 28 cm, increased tuber number per plant from 4 to 8, decreased mean tuber weight per plant at least 25 g and increased total tuber weight per plant from 150 to more than 185g Therefore, applying 1% thiourea is recommendable for minitubers dormancy breaking because of its effect on rapid dormancy breaking, rapid emergence, and increasing minituber number per plant and increasing tuber yield in Marfona minituber production .(Germchi, *et.al*. 2011).

Asthir *et.al*. (2013), conducted the experiment to evaluate the potential of thiourea in improving the terminal heat resistance in bread wheat. Four wheat genotypes PBW 550 and PBW 343 (heat sensitive) and C 306 and C 273 (heat resistant) were field sown at normal time (November) or late (December) to expose the crop to heat stress during grain-filling. Temperature during grain filling was ~25.6oC in normal and 29.4ºC in late sown wheat crop. Prior to sowing, wheat seeds were soaked in 6.6 mM thiourea solution) for 6 h. Thiourea was also applied as foliar spray (6.6 mM) at anthesis. Heat stress, during grain filling, led to disruption of cellular membrane by increasing membrane injury index, lipid peroxide and H_2O_2 contents.However, thiourea application ameliorated the heat-induced damages by stimulating the total antioxidant activity through decrease in lipid peroxidation and membrane injury. Thiourea application also increased the total soluble proteins, amino acids and chlorophyll contents in all the tested genotypes. This all caused substantial increase in plant height, peduncle length, peduncle weight and grain weight. Genotypes PBW 550 and PBW 343 showed higher grain weight in spite of greater injury to membranes over genotypes C 306 and C 273. Combined application of thiourea as seed treatment and foliar spray was more effective in improving the wheat performance by enhancing membrane stability, antioxidant potential and yield components.

Khosa *et .al*. (2011) to observe the effect of foliar purpose of macro (NPK) and micro nutrients (Zn, B,Fe and Mn) on gerbera growth and flowering production. The fertilizer solution of macro nutrients containing 1g, 1.5g and 2g of nitrogen, potassium and phosphorus, respectively and micro power contain 5000±200, 4000±200 and 5000±200mg/100ml solution of Zn, B, Fe and Mn. Different concentration of macro nutrients i.e. 12.5ml+987.5ml water, 18.75ml+981.25ml water and 25ml+975ml water taken and sprayed fifteen days intervals on potted gerbera. Spray of micro power (solution of different micronutrients) was also being applied at constant rate of 5ml/1000 ml solution of water. Plant height, number of branches per plant, length of branches per

plant, number of leave per plant, leaf area, stock length, days to first flower emergence, flower diameter and flower quality increased with increasing fertilization level and began to turn down when fertilization level exceed beyond the above given levels of macro and micro nutrients. Foliar fertilization influenced the days to first flower emergence as compared to control where no foliar spray of macro and micro nutrients was applied. It took 85.55 days in T_3 treatment as compared to control i.e. 105.55 when macro nutrients spray applied and in case of micro nutrients it took 81.88 days in flower emergence as compared to control i.e 100.88.

Mishra *et al*.2011 conducted the study to determine the effect of organic and inorganic sources of NPK and foliar spray of chemicals on plant growth, fruit yield and quality of *ber cv.* Gola. Different graded levels of FYM (37.5, 75 and 150 kg/plant) and Vermicompost (11, 22 and 45 kg/plant) were supplemented with different doses of inorganic fertilizers and foliar spray of chemicals (control, borax 0.4 per cent and thiourea 0.5 per cent) to balance fertilizer requirement of *ber* under semi-arid region of northern India. Experimental results revealed that application of 22 kg vermicompost + 0.82 kg urea + 1.15 kg SSP + 0.41 kg MOP per tree (F_5) and foliar spray of thiourea @ 0.5 per cent (T_2) significantly increased the plant height, plant spread, leaf area, average weight of fruit and fruit yield per tree and reduced the fruit drop. The ascorbic acid and iron content of fruits and NPK uptake by fruits were enhanced alongwith improvement in relative leaf water content (RLWC) and chlorophyll content in leaves under treatment F_5 and T_2. All these parameters were appeared to be dose and source dependent and best results were achieved with the combined application of 22 kg vermicompost + 0.82 kg urea + 1.15 kg SSP + 0.41 kg MOP per tree + foliar spray of thiourea @ 0.5 per cent under integrated nutrient management systems of *ber* orchard.

Germchi *et.al.* (2011) conducted an experiments for studying thiourea application effect on potato minitubers dormancy breaking in Marfona cultivar in greenhouse in 2008. Thiourea in three levels as 0, 0.5, and 1% arranged in a

completely randomized design in three replicates. After dormancy breaking, attributes like as days to sprouting, length of the longest sprout, and sprout number measured. Then minitubers planted in pots and days to emergence, main stem numbers, and plant height measured. Tuber number per plant, yield and mean tuber weight was calculated after harvesting. Results showed that thiourea had significant effect on all attributes except of sprouts number and length of sprouts. Applying 1% thiourea decreased days to sprouting date from 102 to a bit less than 90 days, decreased days to emergence from 38 to 28 days, increased stem number from 1.2 to 2.1, increased plant height at least 28 cm, increased tuber number per plant from 4 to 8, decreased mean tuber weight per plant at least 25 g and increased total tuber weight per plant from 150 to more than 185 g. Therefore, applying 1% thiourea is recommendable for minitubers dormancy breaking because of its effect on rapid dormancy breaking, rapid emergence, and increasing minituber number per plant and increasing tuber yield in Marfona minituber production.

This investigation was inducted at Nubaria Region, West of Alexandria City, Egypt, during 2006 and 2007 seasons to study the influence of different concentrations (0.0,0.2,0.4,0.6,0.8, and 1.0 %) of foliar fertilizer contains macro - elements (20%N, 20% P, 20% K, 0.12% Mg) and micro - elements (70 ppm Fe, 14 ppm Zn, 16 ppm Cu, 42 ppm Mn, 72ppm B and 24 ppm Mo) on the growth, flowering, and chemical analysis of leaves of *Dianthus caryophyllus* cv. "Red Sim". The foliar fertilizer was applied 5 times during the growing period. The results revealed that plant treated with foliar nutrition showed significant increase in the growth characteristics (stem length, stem diameter, stem fresh and dry weight, number of leaves/ plant, fresh and dry weight of leaves). As well as, stimulated the flowering parameters (reducing the number of days from planting to flowering, increased both number, size,fresh and dry weight of flowers/plant) compared to the untreated plants (control). The treatment of 0.6 % of foliar fertilizer gave the highest values compared to the other treatment in both seasons. The total chlorophyll (a+b) , carotenoides and

total carbohydrates (%),the mineral contents of leaves(N,P,K, Zn and Cu) were significantly increased as a result of spraying the plants with foliar fertilizer at different rates compared to the control treatments. (EL -Naggar and EL-Sayed, 2008).

Barman, *et al.*(2007) conducted an experiment to see the effects of phosphorus and thiourea application (either alone or in combination) were studied on clusterbean (Cyamopsis tetragonoloba Taub.) plants subjected to water stress by withholding irrigation at pre- and post-flowering stages in pot culture trial. Water stress significantly decreased shoot water potential, relative water content of leaves, net photosynthetic rate, contents of total chlorophyll, starch and soluble proteins as well as nitrate reductase activity at both the growth stages. Application of phosphorus and thiourea or combined application increased most of these parameters. Results revealed synergistic effects of P and thiourea in enhancing net photosynthesis, leaf area, chlorophyll content and nitrogen metabolism leading to significant improvement in plant growth and seed yield under water stress condition.

Two pot experiments were carried out by Nahed *et al.* (2007) in the greenhouse of National Research Centre, during two successive seasons (2005 and 2006) to study the effect of foliar application with tyrosine (50 and 100 ppm) and zinc (100 and 200 ppm) on growth , flowering and chemical constituents of Salvia farinacea plants. Plant height, number of leaves and branches, fresh and dry weight of (leaves, branches, shoots) and stem diameter in both cuttings for the two seasons were significantly promoted by increasing the concentration of tyrosine from 50 to 100 ppm as well as flowering parameters and chemical constituents. It is clear that 100 ppm of zinc is sufficient to accelerate the growth parameters as well as flowering parameters (length of peduncle, length of main inflorescence, number of inflorescence and florets, and fresh and dry weight of inflorescences/ plant). Zinc at 100 ppm had insignificant effect on chlorophyll a, total free amino acids, nitrogen and protein content compared with zinc 200 ppm in both cuttings. The highest content of chlorophyll a, total

chl. and total caroteniodes in leaves were obtained with zinc at 100 ppm, whereas foliar application 200ppm zinc lead to the highest content of soluble sugars in leaves. Application of tyrosine at 100 ppm followed by zinc at 200 ppm gave the highest value of soluble sugars content. The most promising results were obtained from plants treated with zinc 100 ppm combined with tyrosine 100 ppm which significantly increased growth parameters, flowering parameters and chemical constituents in both cuttings for the two seasons in Salvia farinacea plant.

Macz *et.al*. (2007) conducted an experiments Chrysanthemums and the objectives of this research were to evaluate the effects of reducing nitrogen (N) applications by adding sulfur (S) and to determine if N∗ S interactions occur during the production and postharvest longevity of pot chrysanthemums. Pot chrysanthemum 'White Diamond' was grown in a peat-based medium following a typical production schedule except for fertilization. Plants received N at 50 100, 150, or 200 mg L^{-1}in combination with S at 0, 5, 10, 20, or 80 mg L^{-1}. Variables evaluated were leaf N and S concentration, plant height, leaf area, days to bud set, first flower color, and inflorescence anthesis as well as size and longevity under simulated interior conditions. Applications of 50 mg N L^{-1} resulted in poor leaf N and S concentration and plants of questionable quality, yet maximal postharvest longevity. Nitrogen applied at 100, 150, or 200 mg L^{-1} in combination with at least 10 mg L^{-1} S had acceptable leaf N and S concentrations and produced plants of commercial quality with adequate postharvest longevity. Thus, N applied at 100 mg L^{-1} was the minimum acceptable fertilizer rate. Thus, N applications can be reduced by half when S is applied during commercial production without compromising postharvest longevity.

Gerg *et.al.* (2006) conducted a 2-year field trial to study the effects of seed treatment (500 ppm) or foliar application of 1000 ppm thiourea (at 25 and 40 days after sowing) or a combination of these, on growth, yield, net photosynthesis and nitrogen metabolism of clusterbean (Cyamopsis tetragonoloba (L.) Taub.) grown for two consecutive years (1999 and 2000)

under rainfed conditions of the Indian arid zone. Thiourea application either as pre-sowing seed treatment or as foliar spray significantly increased plant height, leaf area, dry matter production and seed yield as compared to the untreated control plants during both the years. However, maximum favourable effects were obtained with combined application of seed treatment and foliar spray. The beneficial effects of thiourea were attributed to its role in significantly increasing the net photosynthetic rates and the concentrations of total chlorophyll and starch in the leaves. Thiourea also reflected a positive role in enhancing nitrogen metabolism as it significantly increased nitrate reductase activity and concentration of soluble protein in the treated plants. It has been concluded that seed treatment with thiourea followed by foliar spray could significantly improve growth, yield and water use efficiency of rainfed clusterbean under arid conditions due to enhanced photosynthesis and more efficient nitrogen metabolism.

Anitha *et al*.(2004) conducted an Field experiments in the sandy loam soils of Pattambi during the kharif seasons of 2000-2002 revealed that thiourea application consistently increased cowpea productivity under rainfed conditions. Soaking seeds in 500 ppm thiourea solution followed by two sprays (at vegetative and flowering stages) was most effective and increased seed yield by 26% over control. This treatment also resulted in the higher economic benefits and gave an extra return of Rs. 2823 over that of untreated control.

Parihar *et. al*., (1997) conducted an experiment on Effects of nitrogen, sulphur and thiourea application on growth and dry matter production of pearl millet [Pennisetum glaucunm (L.) R. Br.] were studied for three years under arid conditions. On an average, 80 kg N ha-I was as good as 120 kg N ha-1 but proved superior to 40 kg N 110-1 .Depending on the crop growth stage, N at 80 kg ha-I increased the plant height by 15.5 to 40.9% and number of green leaves by 17.1 to 37.0% over the control. Maximum leaf area index (LAI) of 3.5 was recorded with 80 kg N ha as against 2.4 in control plants at peak growth period (45 DAS). Nitrogen application also significantly increased number of tillers and dry matter accumulations. The improvements in crop growth were reflected in increased net assimilation rate (NAR) and crop growth rate (CGR) at 45 and 60 DAS. Soil application of sulphur did not significantly improve any of the growth parameters, inspite of tile low availability of S in soil «10 ppm), indicating presence of efficient sulphur uptake and translocation mechanisms in pearl millet. Thiuourea, seed plus foliar, treatment increased the plant height by 5.7, 7.5 and 9.9 cm over untreated control at 45, 60, and 75 DAS, respectively. The increase in number of green leaves planCI was between 0.9 and 2.6 which increased the LAI by 0.1-0.2 at various growth stages. Additional gain in dry

matter accumulation due to thiourea over untreated control ranged between 1.6-4.7 g planet. The NAR improved from 4.8 g m-2da-1under untreated to 5.4 g m-1day-1with thiourea treatment at 45 DAS. Corresponding improvement in CGR was from 9.9 g m-2day-1t.o 11.4 g m-1day^{-1}. Delayed leaf ageing, slower senescence and increased photosynthetic efficiency led to enhanced growth due to thiourea treatment.

Sahu *et .al*. (1995) conducted an experiment and shoed that the role of thiourea (TU), a sulfhydryl compound, was assessed in wheat via soil and foliar treatments. Results showed that at 30 days after flowering, soil-applied TU treatments did not influence dry matter accumulation or its distribution in leaves, stems, and ears, but foliar-applied treatments brought about significant effects varying with the timing of spray. At harvest, however, soilapplied treatment of 10 kg/ha TU increased the number of ears, grains/ear, weight/grain, biological yield (total above ground biomass), grain yield, and harvest index. Grain yield increased by 17.3% over control. Soil-applied 20 kg/ha TU increased the grain yield by 1.6% over control. Foliar applied treatment of 0.5 kg/ha TU at tillering increased the number of ears, grains/ear, weight/grain, biological yield, grain yield, and harvest index. Grain yield increased by 15.2% over control. Foliar spray of 0.5 kg/ha TU at flowering tended to improve only weight/grain, but biological yield and grain yield increased significantly. Grain yield increased by 6.6% over control. TU spray at both tillering and flowering increased the number of ears, grains/ear, weight/grain, biological yield, grain yield, and harvest index. Grain yield increased by 23.9% over control, and when compared with spray at tillering there was a significant increase of 7.5%. Thus, two foliar sprays of thiourea, at tillering and at flowering, at 1 kg/ha can be recommended for improving wheat productivity.

Sahu *et.al.,* (1993) conducted an experiments and the results of the field experiment showed that seed soaking with thiourea (500 ppm) tended to improve grain yield (13.4 per cent over control), but improvement in biological yield was significant. However, seed soaking plus foliar treatment of thiourea significantly increased both biological and grain yields, besides causing significant improvement in leaf area index and number of green leaves plant"^ The increase in grain yield ha"' was of the order of 34.6 per cent over control. It was further noted that foliar sprays of thiourea (1000 ppm), thiamine (100 ppm) and ascorbic acid (100 ppm) significantly increased leaf area index,

number of green leaves /plantand biological yield/ ha. These treatments also significantly increased grain yield /ha by 40.6, 20.2 and 26.3 per cent, respectively over control. Improvement in maize yield with thiourea, thiamine and ascorbic acid treatments appeared to have resulted from increased photosynthetic efficiency and canopy photosynthesis on account of the biological activity of -SH group. It was also apparent that leaf senescence was delayed under the influence of these chemicals. It is therefore suggested that thiourea, thiamine and ascorbic acid are the potential bioregulators for improving photosynthetic efficiency and grain yield of maize and possibly other cereals, and that thiourea, a sulphydryl compound, holds considerable promise in this context.

Chandroparnik *et.al.* (1992) observed that upon detection of flower buds in durian they might not be followed by normal development unless the variable factors are most prevailed . A small amount of rainfall occurred at dot stage at flower bud development resulted in cessation of development .Escapers of such event may face the situation of uncommercial threshold and scale down the number of developed flower buds, which lead to difficult subsequent management of the crop .Influence of thiourea on flower bud in counteract with the effect of the rain was then conducted. Thiourea at three; 500,1000 and 1500 ppm were sprayed on branches of durian trees pretreated with 1000 ppm pactobutrazole The application done when the first stage of flower bud development was detected. Thiourea can intensify the number of inflorescence per unit length of branch resulting in higher number of tree .A positive correlation (r= 0.666) between the thiourea concentration and flower density was very promising .An increase of 75% total number of flower per tree was observed.

Hernandez-Nistal *et al*. (1983) observed that uring the first 12 h of germination of Cicer arietinum L. (cv. Castellans) seeds, K+ is first lost into the surrounding medium and is later reabsorbed. Thiourea accelerates this reabsorption. Since there is an increase in the mobilization of K+ in response to

thiourea, a greater accumulation of malate due to the carboxylation of phosphoenolpyruvic acid takes place as compared with that occurring in water. The subapical zone of the radicle accumulates the greatest amounts of water, K^+ and malate. The variation in the “in vitro” activity of phosphoenolpyruvate carboxylase does not explain the difference in malate in response to the different treatments, consequently there must be chemical changes in the cytoplasm which favour this carboxylation “in vivo”. These results show that thiourea accelerates the mobilization of K+ and stimulates the dark fixation of CO_2 in embryonic axes of Cicer arietinum.

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

This chapter illustrates information concerning methodology that was used for execution of the experiment. A field experiment was conducted at the Horticulture farm of Sher-e-Bangla agricultural University, Dhaka, Bangladesh during the period from November 2018 to May 2019 to compare different concentrations and application frequencies of thiourea on lisianthus pink variety. The materials and methods used for the experiment were as follows:

3.1 Experimental site

The study was conducted in the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to study the performance of different concentrations and application frequencies of thiourea on growth, flower quality and yield on light pink lisianthus variety. The location of the experimental site is 23º74'N latitude and 90º35' E longitude and at an elevation of 8.2 m from sea level (Anon., 1989) in Agro Ecological Zone of Madhupur Tract (AEZ No.28)

3.2 Climatic condition

Experimental site was located in the subtropical monsoon climatic zone, set a parted by heavy rainfall during the months from April to September (Kharif season) and scant of rainfall during the rest of the year (Rabi season). Plenty of sunshine and moderately low temperature prevails during October to March (Rabi season), which is generally preferred for flower production in Bangladesh.

3.3 Planting materials

Lisianthus seeds were collected from Takii seed Co. Japan. November 2018. The seeds were sown in 200 hole plug trays filled with growth medium and placed in lisianthus growth chamber for germination and subsequent growth. Required care for proper development of seedlings were taken.

3.4 Land preparation

The experimental area was brought to fine tilth with cross ploughing using power tiller. Then the area was divided to plots of 3m×1m according to the layout of the experiment (Figure 1).The following amount of manures and fertilizer were used (rate/hectare) which shown in below.

Manures and fertilizer with BARI recommended doses of marigold was followed -

- Cowdung- 5 t/ha
- Urea- 250 Kg/ha
- TSP- 200 Kg/ha
- MoP- 150 Kg/ha

All these were applied to the plot soil during final land preparation. Black polythene mulch was used for eliminate the weeds, warming up the soil, as well as for retaining the soil moisture.

3.5 Transplanting of seedlings

Healthy uniform and rosette free seedlings were transplanted in the main field. The seedlings were uprooted carefully from seed tray to avoid any damage to the root system. 65 days old seedlings (with 4 pair true leaves) were taken for transplanting in the field. A conciderable number of seedlings were also planted in the border of the experimental plots for gap filling.

3.6 Treatments of the experiment

Factor A: Different concentration of thiourea

Thiourea was applied in different concentration as folier application .The treatments were,

C_1= 0.5 g/L= 500 ppm
C_2= 1.0 g/L= 1000 ppm
C_3= 1.5g/L= 1500 ppm

Factor B: Different Application frequency

Thiourea applied in this experiment as

T_0= Control (No thiourea application)

T_1= Once application (20 Days after transplanting)

T_2= Twice application (20 and 45 days after transplanting)

The treatment combinations were:

C_1T_0, C_1T_1, C_1T_2, C_2T_0, C_2T_1, C_2T_2, C_3T_0, C_3T_1, C_3T_2

From C_1T_0, C_2T_0, C_3T_0 treatment combination similar result was found. For this reason these three treatment combinations are combindly denoted as C_0T_0.

3.7 Application of Thiourea

Application of thiourea was done to the lisianthus field as folier application to the whole plant. First application was done at 20 days after transplanting and twice application was done at 45 days after transplanting (plate 1c).

3.8. Design and layout of the experiment

The two factorial experiments were laid out in Randomized Complete Blocked Design (RCBD) with three replications thus comprised 27 plots in the experiment (Figure 1).

3.8.1 Spacing and plot size

The size of each plot was 1.8×1.2 m. The distance between blocks and plots were 0.5 m and 1 m respectively. 30 cm distance from row to row and 20 cm distance from plant to plant was maintained in each replications and 36 plants were transplanted in a plot.

3.9 Intercultural operations

Following operations were done,

3.9.1 Irrigation

During seedling development, mist irrigation was provided using a hand sprayer to keep the growth medium moist. After transplanting of the seedlings, over-head irrigation was provided through a pipe as and when necessary during the experimental period.

3.9.2 Fertilization

The soil was mixed with NPK as it increases the production of lisianthus.

3.9.3 Weeding

Weeding was done as and when necessary.

3.9.4 Disease and pest control

To prevent the all kind of fungal attack the seedlings were treated with fungicide before transplanting. Again to prevent fungal infection, Dithane M-45 was sprayed 3 times at 15 days interval along with Ripcord @ 1.5ml/L to prevent insect attack. In vegetative stage, trichoderma also sprayed to control nematode and other soil born pathogens .During soil preparation trichoderma compost also applied to soil because trichoderma remain under high risk of Fusarium attack. And trichoderma is very effective to control fusarium.

3.9.5 Staking

Staking was provided to the plants using bamboo sticks.

3.10 Harvesting of flower

Flower sticks were harvested in 2 times when the flower reach commercial stage.

3.11 Parameters studied

1. Growth parameters:

- Plant height (cm)
- No of leaves/plant
- No of stems /plant
- Days to first flower bud emergence
- No. of flower /stem
- No of flower/plant
- Stem length(cm)
- Peduncle length(cm)
- Peduncle diameter(mm)
- Stem diameter(mm)
- Receptacle diameter(mm)

2. Physiological parameters:

- SPAD value

3. Yield parameters:

- Flower yield/plant
- Flower head diameter (cm)
- Flower Yield /plot

4. Quality attributes parameters

- Petal color measurement (CIE lab Colorimeter)
- No. of petal per plant

3.12 Data collection for the experiment

Three plants were randomely selected from each unit of plot for the collection of data. The plants in the outer rows and the extreme end of the middle rows were excluded from the random selection to avoid the border effect. However, the yield of of all plants was considered per plot yield. Data have been collected on the basis of four attributed like- growth related parameters, physiological parameters, yield attributing parameters and quality attributes parameters

3.12.1 Plant height (cm)

Plant height was measured using a graduated measuring scale at mature stage of the plant (Plate1e.).

3.12.2 Number of leaves/plant

Total no. of leaves was determined by counting all the leaves from the base to the tip of the plant at maturity.

3.12.3 SPAD value

Chlorophyll percentage was measured using a portable chlorophyll meter (SPAD-502, Minolta, Japan). The procedure of this measurement was non-destructive. Data were collected from five randomly selected leaves taking three data from each leaves and the mean was derived from them (Plate1f).

3.12.4 No of stem per plant

No. of flowering stem was measured by counting the stems containing flowers and flower buds**.**

3.12.5 Stem length (cm)

Stem length was measured using a measuring scale from each of the flowering ones. The measurement was done from the first internode from the soil and recorded in centimeter (cm).

3.12.6 Stem diameter

Peduncle diameter was measured using Digital caliper-515 (DC-515) in millimeter (mm). Mean value as derived from the collected data. (Plate 2j)

3.12.7 Days to flower bud initiation

Days to flower bud initiation was determined by counting from the days of transplanting to the appearance of the first flower bud.

3.12.8 Number of flower buds/stem

No. of flower buds/stem was counted up to blooming of the first flower and the mean value was calculated.

3.12.9 Number of flower/stem

Number of flower /branch was counted and the mean value was calculated.

3.12.10 Number of flower/plant

No. of flower/plant was counted at the end of the experiment just before harvesting and the mean value was calculated.

3.12.11 Flower Yield /plot

3.12.12 Peduncle length

Peduncle length was measured using a measuring scale from each of the flowering ones. The measurement was done from the first internode from the soil and recorded in centimeter (cm). (plate1.i)

3.12.13 Peduncle diameter

Receptacle diameter was measured using Digital caliper-515 (DC-515) in millimeter (mm).

3.12.14 Receptacle diameter

Receptacle diameter was measured using Digital caliper-515 (DC-515) in millimeter (mm).

3.12.15 Flower head diameter

Flower head diameter was measured using Digital caliper-515 (DC-515) in millimeter (cm). The data was then converted to centimeter.

3.12.16 Number of petal/flower

No. of petal/ flower was counted from the second bloomed flower and mean value was derived from them (Plate 2h.).The second flower was chosen because petal number and the size of the flower often vary on the first flower to open but is generally consistent on all secondary flowers**.**

3.12.17 Petal color measurement

Colorimetric measurement of the different treatment combinations was done using IWAVE WF32 precision colorimeter (Shenzhen Wave) following L* (lightness), a* and b* (two Cartesian coordinates) including C* and hab (Chroma & hue angle) based on 37 CIE Lab scale with standard observer 100 and standard illumination D65 (CIE, 1986; Mc Guire, 1992) (Plate 2.). Beams effective axes were at 45±20 from the normal of the specimen surface in illuminated petals. Metric chroma, C* and hue angel, hab were calculated as $C^* = (a^{*2}+b^{*2})0.5$ and $h_{ab} = tang^{-1}$ (b*/a*) the individual petals were separated and were placed under the measurement port for color measurement. In case of bi-color lines the distinguishing color portion of the petals were arranged under the measuring port of the colorimeter and test was conducted.

3.13 Statistical analysis

The data recorded for differents parameters were statistically analysed using of Statistics-10 scientific analysis software to find out the significance of variation among the treatments means were compared by Least Significant difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

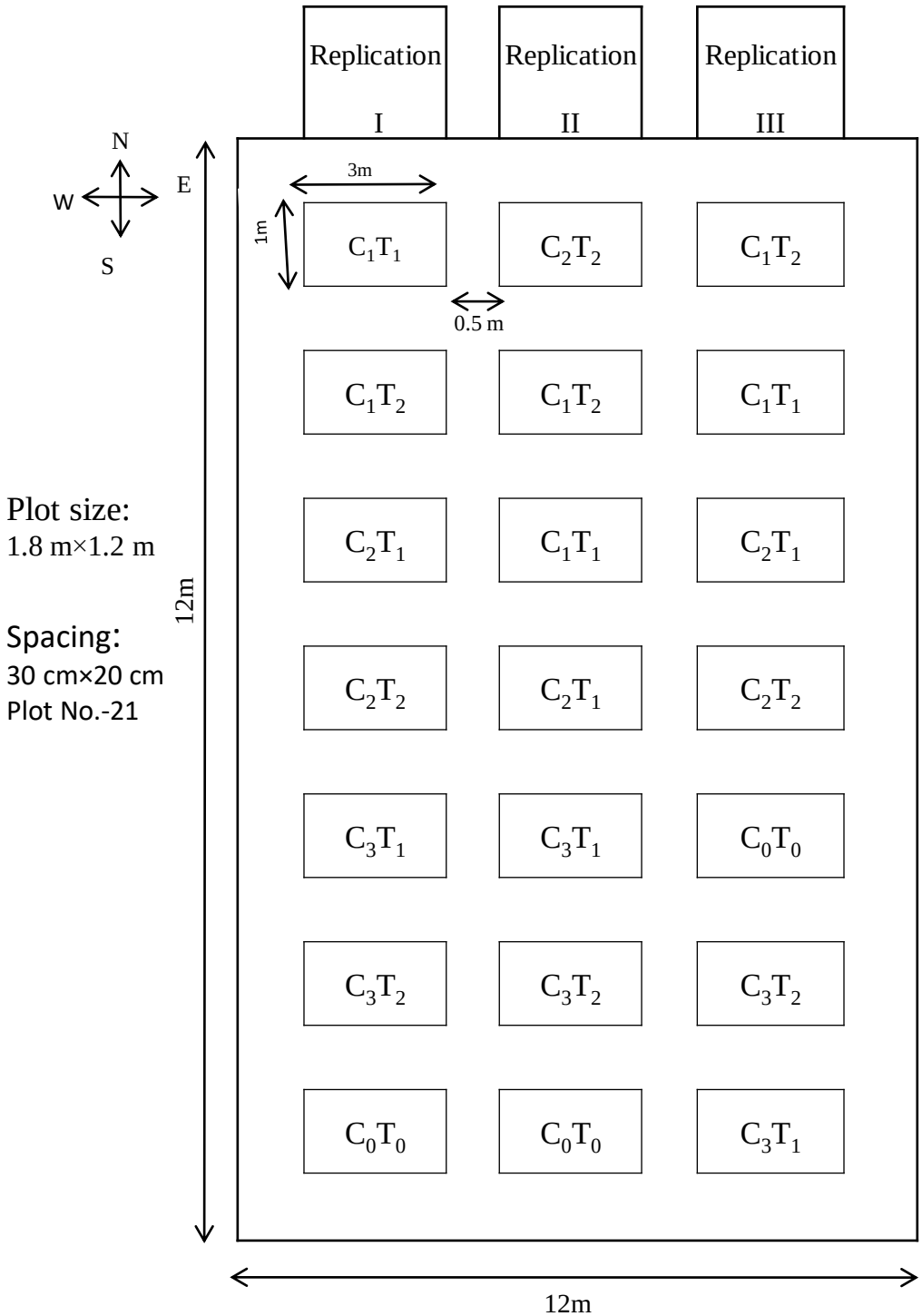


Figure.1: Layout of the Exprtient

(a)

(b)

(c)

(d)

(e)

(f)

Plate 1.Photographs showing, a. 65 days old Seedlings for transplanting, **b.** Thiourea **c.** Treatments was being given to the field, **d.** Data collection, **e.** Measurement of plant height using measuring scale ,f. SPAD value measurement using SPAD-502 chlorophyll meter.

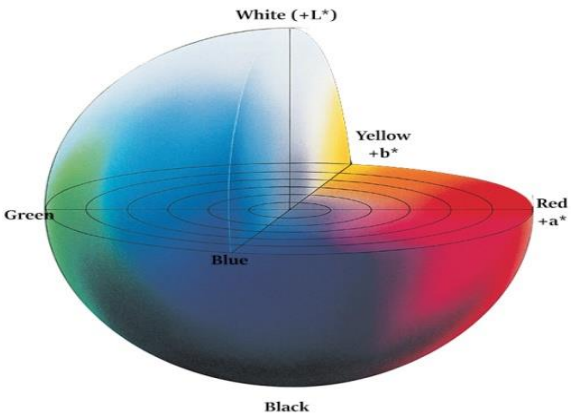
(g)

(h)

(i)

(j)

(k)



(l

Plate 1. g. Measurement of flower head diameter using Digital caliper -515, h. Counting no. Of petal in a single flower, i. Measuring of Peduncle length using measuring scale, j. Measurement of Stem diameter using Digital Caliper -515, k. Colorimeter, l. CIE lab color scale .

CHAPTER IV

RESULT AND DISCUSSION

CHAPTER IV
RESULTS AND DISSCUSION

The research work was conducted for the evaluation and compare of the performance different concentrations and application frequencies of thiourea on lisianthus light pink variety. The research work on "Influence of thiourea concentrations and applications frequency on growth and yield of Light Pink Lisianthus" was undertaken in the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka. The experimental results on growth, yield and quality parameters obtained during the entire period of study are presented as follows:

4.1 Plant height

Plant height (cm) is obviously important growth parameters in lisianthus which is positively correlated with yield and the growing conditions significantly influenced this trait (Appendix I). Results revealed that foliar application of thiourea showed significantly higher values of all as compared to control at 30 days, 45 days, 60 days, 75 days, and 90 days after transplanting. The maximum plant height was at 90 days after transplanting. Significant result was observed at different concentrations of thiourea application. The highest plant height (59.6 cm) was recorded from C_3 (1500 ppm) treatments while minimum result was found in C_1 (500 ppm) treatments (52.8 cm) (Figure-2) of thiourea while lowest plant length was observed in control treatment. Similar result was observed in maize (Sahu *et al.,* 1993), wheat (Sahu *et al*., 1995), pearl millet (Parihar *et al.,* 1997) and cluster bean (Garg *et al.,* 2006).

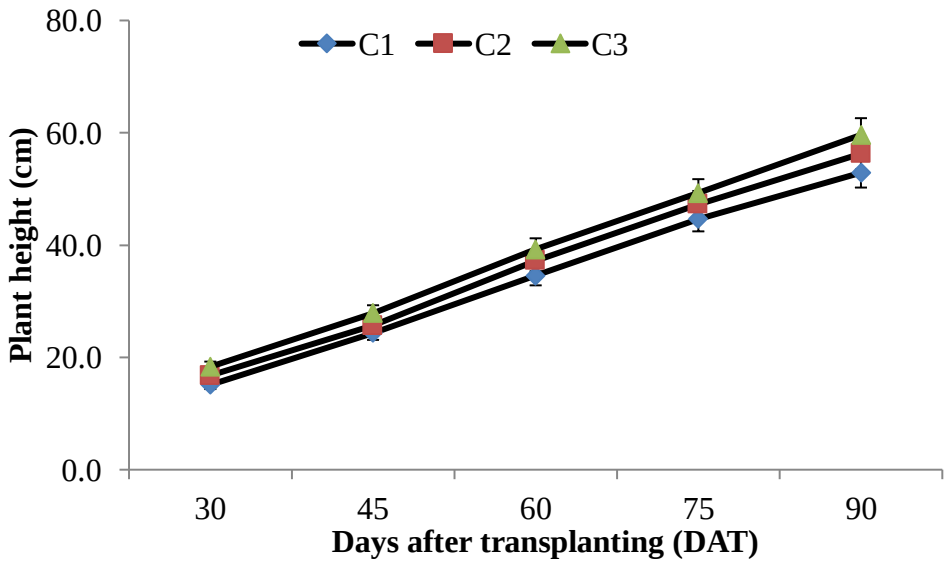


Figure 2. Performance of different concentrations of thiourea on plant height (cm) at different days after transplanting (Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm)

Plant height was significantly affected by different application frequency of thiourea (Appendix I).The highest plant height (61.3 cm) was recorded from T_2 (twice application) at 90 days after transplanting while lowest plant height (49.0 cm) was observed in control treatment (Figure 3).Similar result observed by (Asthir *et al.*, 2013; Zain *et al.*, (2017) also revealed that foliar application of thiourea showed significantly higher values of all growth parameters as compared to control.

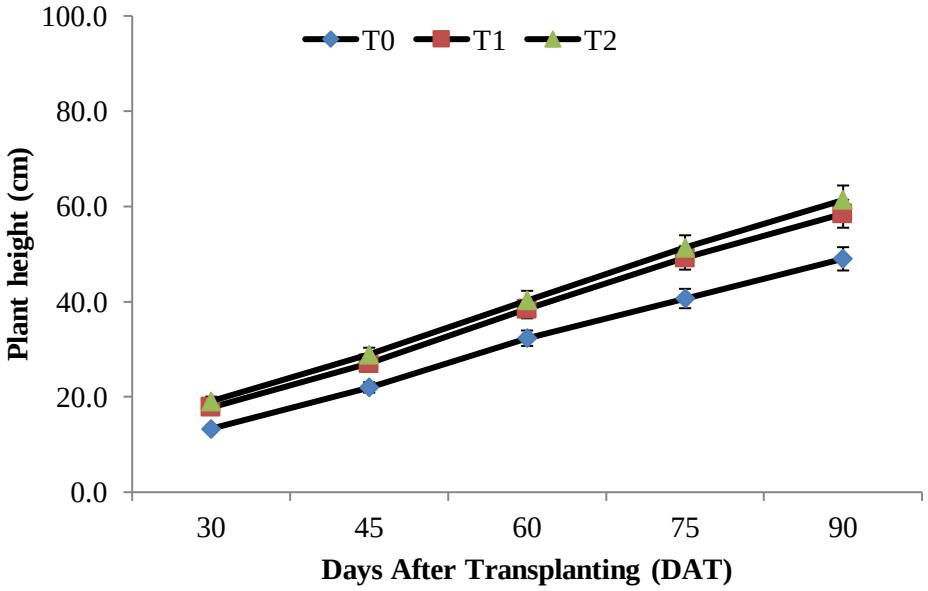


Figure 3. Effect of thiourea application on plant height (cm) at different days after transplanting (Here, T_0: No thiourea application; T_1: Single application T_2: Twice application)

In case of combination of concentrations and application frequencies plant height also exposed significant variation (Appendix I). The tallest plant (66.1 cm) was found in combined effect of double application (T_2) and C_3(1500 ppm) concentrations at (C_3T_2) as well as the shortest plant (49.0cm) was found in (C_0T_0) (Table 1). Abhishek *et al*., 2020 reported that Thiourea improves the photosynthetic activities that triggered vigorous growth and increased plant height. Foliar spray of thiourea increased crop photosynthetic efficiency and source sink relationship and increased rate of cell division ultimately increased the Plant height.

Table 1. Combined effect of different concentrations and application frequencies of thiourea on plant height of lisianthus at different days after transplanting

	Plant height (cm)				
Treatment	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
C_0T_0	13.3 f	22.0 f	32.3 f	40.6 g	49.0 e
C_1T_1	15.5 e	24.8 e	34.8 e	45.2 f	53.3 d
C_1T_2	16.5 d	26.1 d	36.5 d	48.1 e	56.3 c
C_2T_1	17.6 c	26.6 d	38.5 c	49.6 d	58.3 c
C_2T_2	19.3 b	28.3 c	40.8 b	51.5 c	61.5 b
C_3T_1	20.1 b	29.5 b	41.9 b	52.6 b	63.7 b
C_3T_2	21.5 a	32.1 a	43.4 a	54.5 a	66.1 a
LSD	0.9	1.1	1.1	0.9	2.3
CV%	3.1	2.4	1.8	1.2	2.4

Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm and T_0: No thiourea application; T_1: Single application T_2: Twice application); C_1T_0, C_2T_0, C_3T_0 treatments combination referred to as C_0T_0.

** In a column, means having similar letter (s) were statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2 Number of leaves/plant

Leaves are the important organ which helps to physiological processes, photosynthesis and transpirations. Number of leaves showed significant variation in the different treatment under study (Appendix II). Maximum number of leaves was observed in C_3 (67.7) and the minimum was observed in C_1 (48.8) at 80 days after transplanting (Figure 4). Uddin, *et al.* (2019) observed significant variation was found on number of leaf in different thiourea treatment .If there is increase in folier fertilizer concentrations in leaves there is increase in number of leaves was reported by Khosa *et al*., (2011).

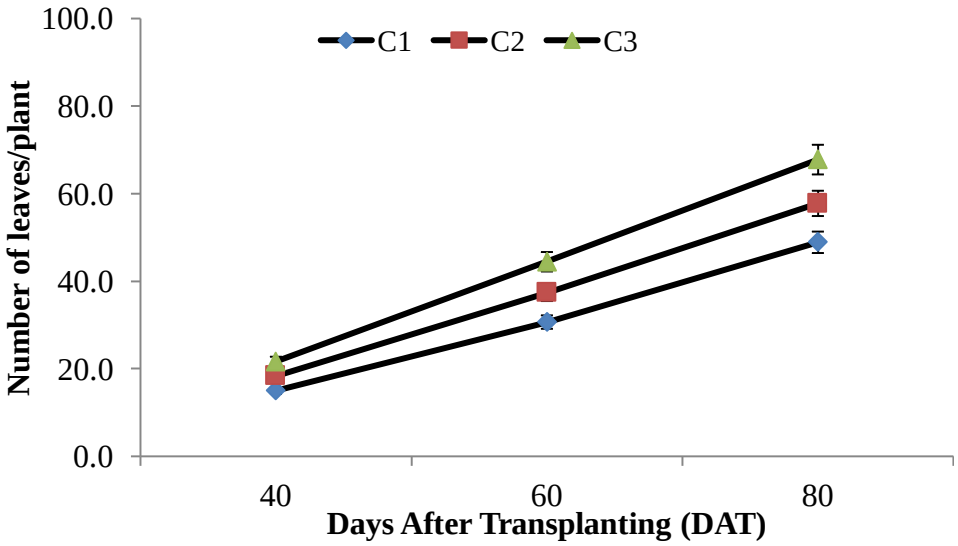


Figure 4. Performance of different concentrations of thiourea on number of leavesper plant at different days after transplanting (Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm)

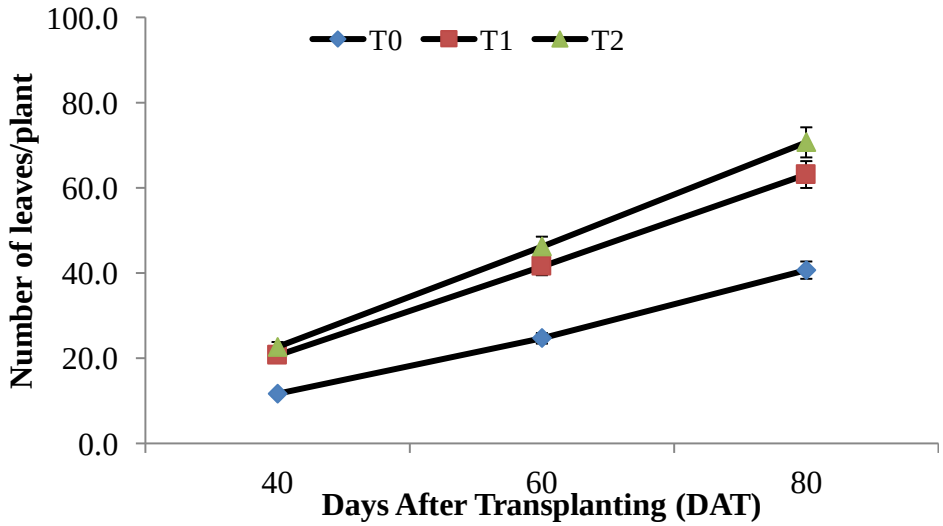


Figure 5. Effect of thiourea application on number of leaves per plant at different days after transplanting (Here, T_0: No thiourea application; T_1: Single application T_2: Twice application)

Again among the different application frequency the best result found in T_2 (twice application at 20 and 45 DAT) and the no. of leaves is (70.6) where the lowest result found in T_0 (40.6) at 80 DAT (Figure 5). Uddin *et al.*, (2020) reported that application frequency of thiourea increased leaf number of okra.

Table 2. Combined effect of different concentrations and application frequencies of thiourea numbere leaves per plant of lisianthus at different days after transplanting

	Number of leaves		
Treatment	30 DAT	45 DAT	60 DAT
C_0T_0	11.6 g	24.6 g	40.6 g
C_1T_1	16.0 f	32.0 f	50.6 f
C_1T_2	17.3 e	35.3 e	55.3 e
C_2T_1	20.0 d	40.6 d	60.6 d
C_2T_2	23.3 c	46.6 c	72.0 c
C_3T_1	26.0 b	52.0 b	78.0 b
C_3T_2	27.3 a	56.6 a	84.6 a
LSD	1.1	1.7	4.1
CV%	3.6	2.7	4.1

Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm and T_0: No thiourea application; T_1: Single application T_2: Twice application and C_1T_0, C_2T_0, C_3T_0 treatments combination referred to as C_0T_0

** In a column, means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

In case of combined effect of thiourea concentrations and application frequency significant variation was observed in the number of leaves per plant (Appendix II). The maximum number of leaves (84.6) was found from C_3 (TU concentrsation 1500 ppm) with double application (T_2) of thiourea (C_3T_2) and minimum (40.6) at C_0T_0 (Table 2). (Appendix II). This positive changes in the crop might be ascribed to better growth and development of crop with thiourea treatment action possibly targeted the meristematic activity of apical tissues with stimulatory effects on cell division which causes increase in shoot length and cell number for improved

vegetative growth (mostly by increased sulphur and nitrogen nutrition) (Khosa, *et al.*, (2011). Thiourea transports N from source to sink that regulates photosynthesis and increased leaf number. The thiourea with its sulphydryl group regulates several metabolic reactions in the plant both under normal as well as stress conditions.

4.3 SPAD value

Chlorophyll enhances the growth of a plant which is correlated with the yield. Chlorophyll (%) on leaves (SPAD reading) showed significant variation among the different treatments under study (Appendix III). The highest chlorophyll content (56.6) was observed from C_3 whereas the lowest chlorophyll content (52.5) was observed from C_1 treatment. (Figure-6). SPAD value increased due to thiourea application, because of availability of nitrozen and sulphur fertilizer similarly as reported by Skudra and Ruza (2017).

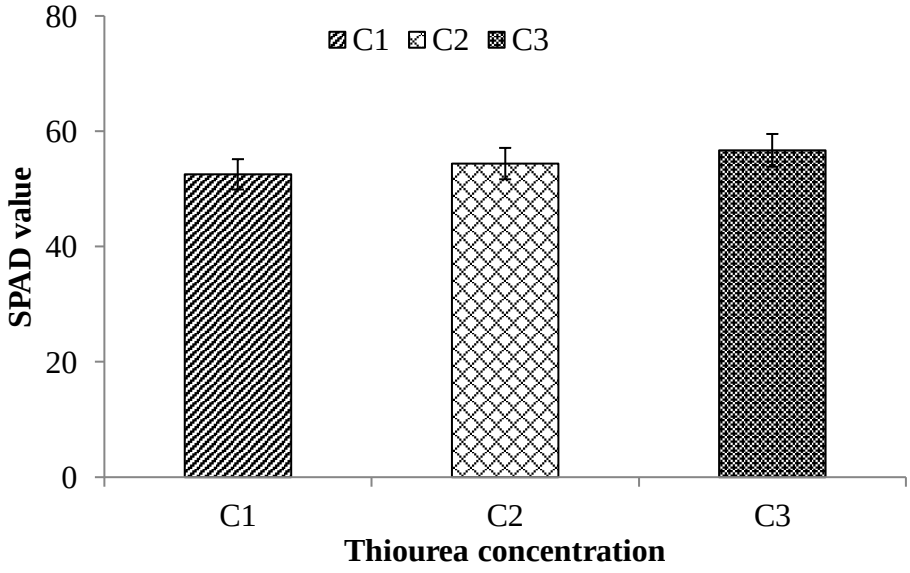


Figure 6. Performance of different concentrations of thiourea on SPAD value of leaves at different days after transplanting.(Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm)

Again In different application frequency chlorophyll percentage of leaves showed significant variation (Appendix III). Maximum chlorophyll percentage (59.2) was found twice application of thiourea treatment (T_2) and minimum (52.5) was observed in control condition (T_0) (Figure.7)**.** Similar Variation in results is also observed by Uddin *et al.*, (2019).

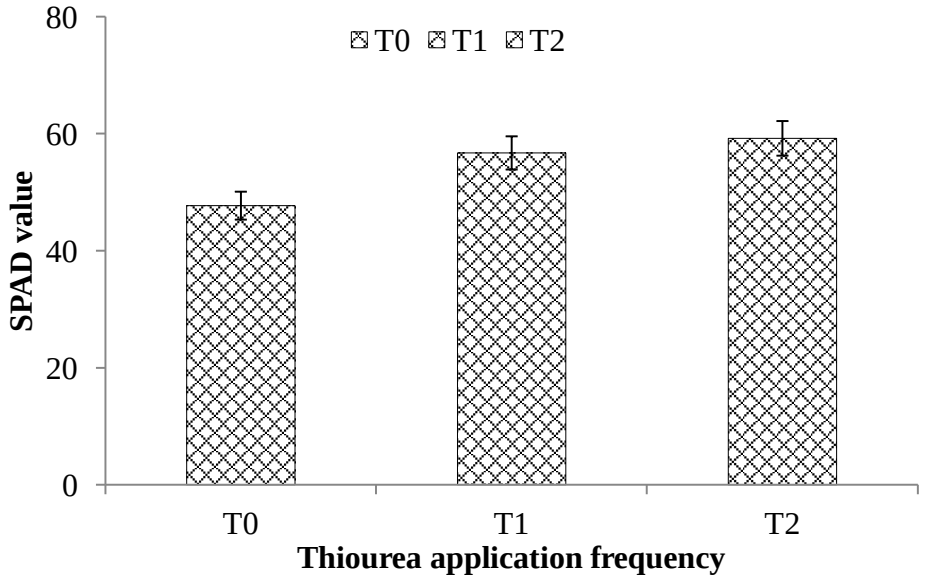


Figure 7. Effect of Thiourea application on SPAD value of leaves at different days after transplanting (Here, T_0: No thiourea application; T_1: Single application T_2: Twice application)

Combination treatment had significant variation on chlorophyll content of leaves (Appendix III). The utmost chlorophyll percentage of leaves (62.7) was found in (C_3T_2) and minimum chlorophyll percentage of leaves (47.7) was found from (C_0T_0) (Table-3).Chlorophyll content of leaves is frequently correlated with photosynthetic capacity, with leaf N status. Foliar application of either BA or TU at any concentration or their combination significantly increased the Chl a, b and a+b, carotenoids and consequently the TPC more than controls reported by Amin *et al.(2016).*

3.4 No. of Stem per plant

Number of branches showed significant inequality in different treatments under study (Appendix III). Among the different concentrations of Thiourea imposed to lisianthus plants, C_3 (thiourea @ 1500 ppm) recorded significantly maximum branch number (4.4) and minimum from C_1 (3.2) (Figure 8).

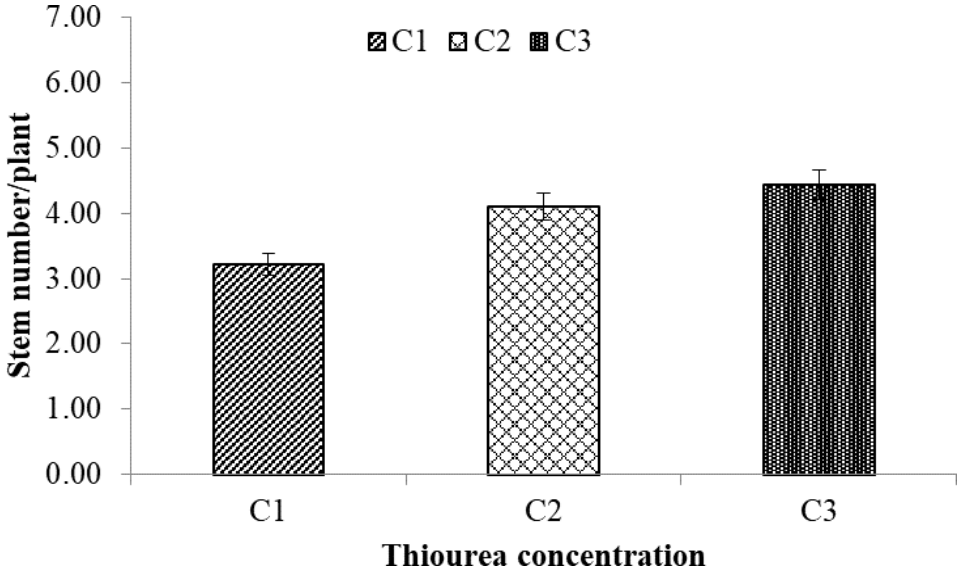


Figure 8. Performance of different concentrations of thiourea on no. of stem per plant at different days after transplanting (Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm)

Again at twice application (T_2) of thiourea (at 20 and 45 Days after transplanting) showed maximum result (5) compared to control T_0 (2.3). (Figure 9). These results are well supported with the findings of Burman *et al.* (2004) due to foliar spray of thiourea @ 1500 mg L^{-1} who noticed increased nitrogen uptake, metabolic processes and hence increased the clusterbean growth and dry matter accumulation. Similarly (Sahu *et al.*, 1993; Garg *et al.*, 2006) also reported a significant increase in the number of branches as a result of foliar spray of thiourea.

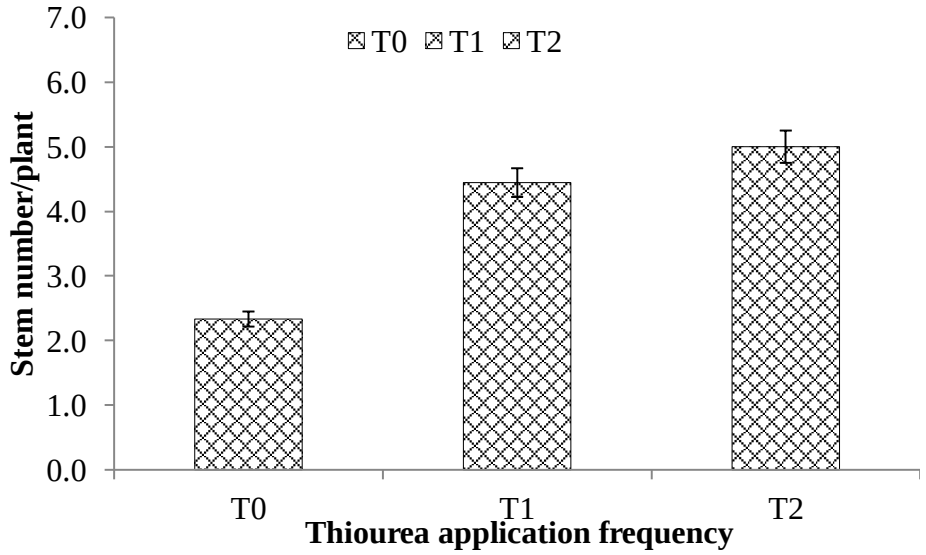


Figure 9. Effect of Thiourea application on no. of stem per plant at different days after transplanting

(Here, T_0: No thiourea application; T_1: Single application T_2: Twice application)

In case of combination of concentrations and application frequencies maximum number of branches was observed in C_3T_2 (5.3) which is nearly similar to theresult found from C_3T_1 (5.3) and C_2T_2 (5.3). The lowest value was observed by C_0T_0 (2.3) (Table.3).Amin *et al*., (2016) observed that foliar application of Benzoic acid and Thiourea alone or in combination significantly increased the tiller numberof wheat plants. Thiourea increase N uptake and metabolic process that regulates the growth of plant. Branch number was increased in different thiourea treatment and significant variation was showed in Garlic Chives (Uddin *et al.,* 2019). Premaradhya *et al.,* (2018) also reported similar result for lentil. Thiourea (TU) plays several bioregulatory roles in plants, as the sulfhydryl group has diverse biological activities promoted growth and photosynthetic pigments which increased vegetative growth of the plant.

4.5 Stem length (cm)

Stem length of different treatments on lisianthus under study exposed significant variations (Appendix III). Among the various concentrations the maximum (43.9 m) stem length was found in C_3 (thiourea @ 1500 ppm) and and minimum (38.7 cm)was found in C_1 (Figure.10) .Thiourea was more effective than BA in increasing vegetative growth of wheat plants at different growth stages was reported by Amin *et al.* (2016).

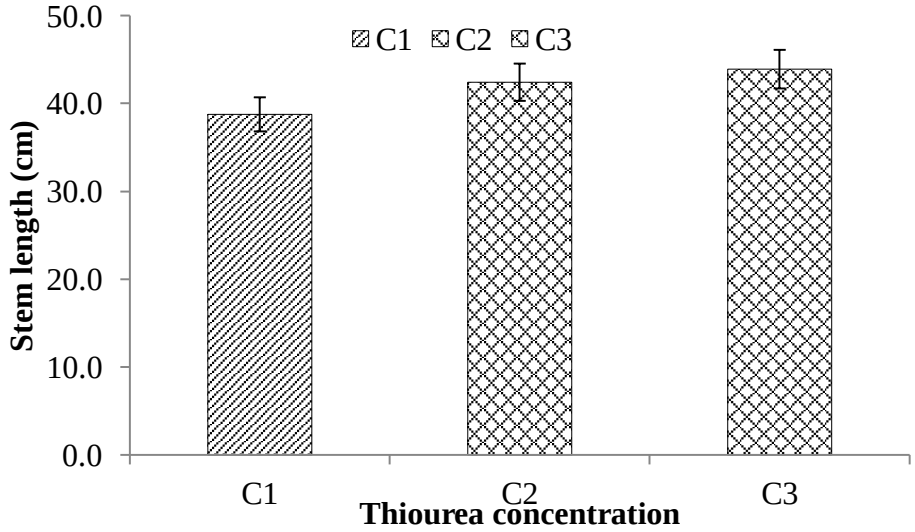


Figure 10. Performance of different concentrations of thiourea on stem length (Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm)

Again twice application (T_2) showed the best result compared to control T_0. Maximum (47.3 cm) Stem length was found from (T_2) and minimum (34.2 cm) was found from (T_0) (Figure 11**)**. Uddin *et.al.*,(2019) reported that the highest pseudo stem length was found in twice application of thiourea while the lowestresult found from no application of thiourea.

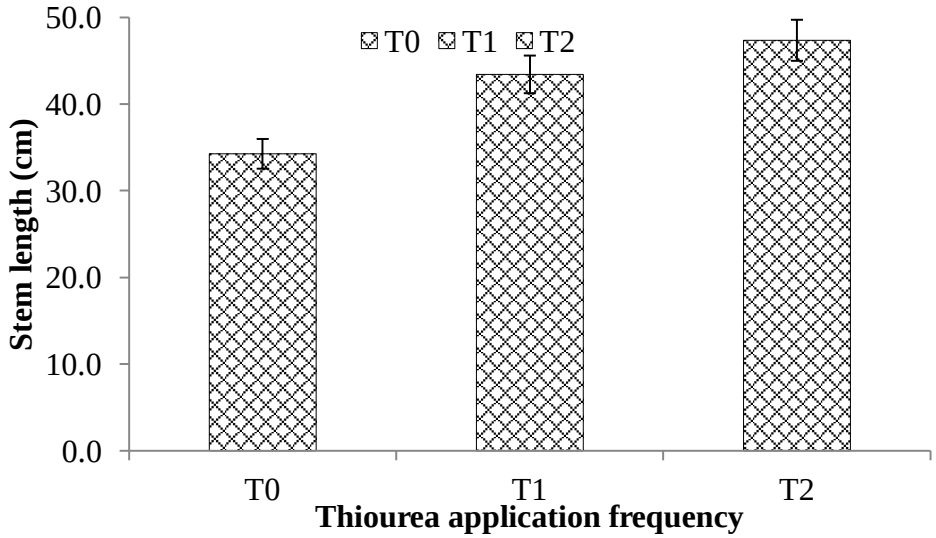


Figure 11. Effect of thiourea application on Stem length
(Here, T_0: No thiourea application; T_1: Single application T_2: Twice application)

In case of combined effect of thiourea concentrations and frequencies the longest stem was shown by C_3T_2 (51.1 cm) and the shortest stem was observed in C_0T_0 (34.2 cm) (Table.3). Verma *et al.,* (2017) reported that application of thiourea (seedling dip + foliar spray) resulted in better utilization of nitrogen and phosphorus in soil probably due to the fact that application of thiourea might have helped in improved metabolic process of plants and better growth & development leading to greater absorption of nutrients from rhizosphere. The sulphydryl compound of thiourea significantly improved the vegetative growth of the plants. This might be due to metabolic role of –SH group in plants physiology.

4.6 Stem diameter (mm)

The difference in treatments under study significant variations was found in diameter of stems (Appendix III). Where, maximum stem diameter was recorded (4.0 mm) in C_3 (Thiourea-1500 ppm), and the lowest diameter of stem was (3.6 mm) in C_1 (Figure12). Variation in stem diameter due to different concentrations was reported by Saleem *et al*. (2019) in sunflower.

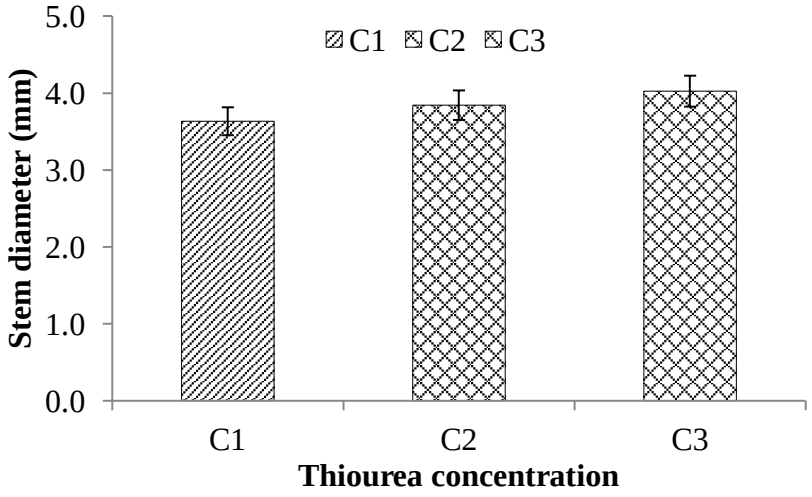


Figure12. Performance of different concentrations of thiourea on Stem diameter.(Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm)

In case of different application frequency significant variation was observed in the stem diameter (Appendix III). Maximum stem diameter was (4.3 mm) recorded in double application of thiourea (T_2) and minimum stem diameter (3.0 mm) was found in control treatment (T_0) (Figure 13). This is due to the foliar application of thiourea. Similar result was observed by EL- Naggar and EL-Sayed (2008) .This is attributed to the fact that, in addition to growth-regulatory roles, these compounds present in thiourea are metabolized and provide as a source of nitrogen nutrition that helps in plant growth and development.

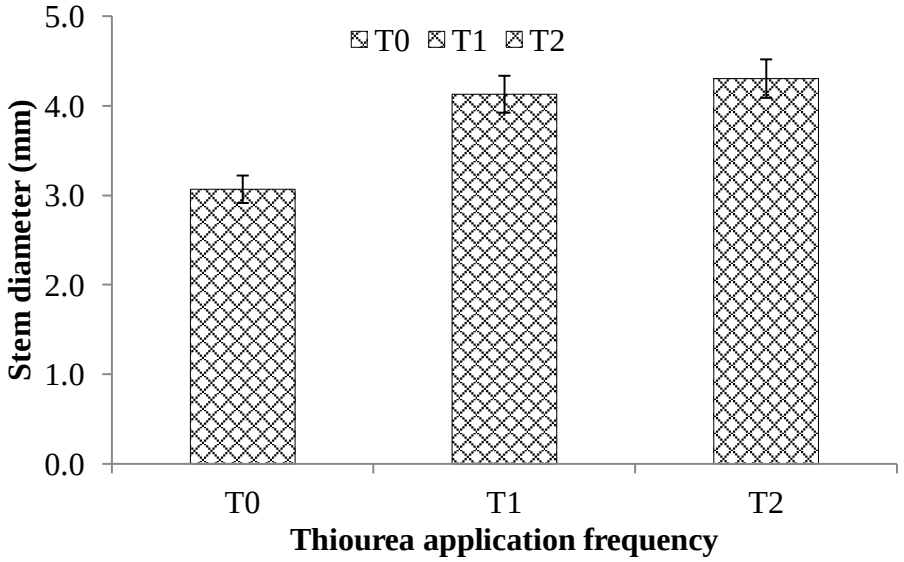


Figure 13. Effect of thiourea application on stem diameter (Here, T_0: No thiourea application; T_1: Single application T_2: Twice application).

In case of combined effect of thiourea concentrations (500, 1000, 1500 ppm) and application frequency at 20 and 45 DAT in lisianthus diameter of stem showed significant variation (Appendix III).The highest diameter (4.6 mm) was found in (C_3T_2) where concentration C_3 is (1500 ppm) and T_2 is two time application of thiourea and minimum stem diameter (3.0 mm) was found in C_0T_0 (Table.3)

Table 3. Combined effect of different thiourea concentrations and application frequency on SPAD value, number of stem per plant, stem length and stem diameter of lisianthus

Treatment	SPAD value	stem number	stem length (cm)	stem diameter (mm)
C_0T_0	47.7 e	2.3 d	34.2 e	3.0 e
C_1T_1	53.8 d	3.3 cd	39.8 d	3.8 d
C_1T_2	56.0 cd	4.0 bc	42.1 cd	3.9 cd
C_2T_1	56.6 b-d	4.6 ab	44.1 cd	4.1 bc
C_2T_2	58.8 bc	5.3 a	48.8 bc	4.3 b
C_3T_1	59.6 b	5.3 a	46.3 ab	4.3 ab
C_3T_2	62.7 a	5.6 a	51.1 a	4.6 a
LSD	3.0	1.1	4.4	0.2
CV%	3.2	17.4	6.1	4.2

Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm and T_0: No thiourea application; T_1: Single application T_2: Twice application and C_1T_0, C_2T_0, C_3T_0 treatments combination referred to as C_0T_0.

** In a column, means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.7 Days to flower bud initiation

There was significant effect of thiourea on days for first flower bud initiations and flowering. The minimum (68.1 days) for first flower bud initiation was with T_2 treatment and maximum (76.3 days) for the plants which are under T_0 (control) treatments (Table-5). Foliar application of thiourea at different concentrations and application frequencies give the best results to flowering characteristics that means enhanced flowers quality and reduced emergence days of flower bud. The minimum days required for flower bud initiation was observed in C_3 (69.1 days) and C_1 took maximum (73.7 days) (Table-4). Folier application of macro nutrients solution decreases the number of days to first flower emergence in Gerbera reported by Khosa *et.al* (2011).Combination treatment had significant variation on days to flower bud initiation (Appendix IV).The best result (64.6 days) was found from (C_3T_2) and maximum (76.3 days) was needed in case of control (C_0T_0)

4.8 Number of flower buds/stem

Variation in number of flower bud/stem was observed among the different treatments under study (Appendix IV). Highest (9.2) number of bud/stem was observed in C_3 treatment and the lowest no. of flower bud/stem (6.8) was observed in C_1 treatment (Table- 4). Similarly, the maximum number of panicles per terminal and flowering shoots were noted by Patel *et al.*, (2016).Again fromdifferent application frequency highest (9.4) no. of flower bud /stem was observed at twice (T_2) application of thiourea at 20 and 45 days after transplanting and the lowest (5.5) was observed in T_0 treatment (Table-5). In case of combination of concentrations and application frequencies number of flower bud/stem also exposed significant variation (Appendix IV). The maximum no. of flower bud/stem (11.5) was found in double application and in 1500 ppm concentrations at (C_3T_2) as well as the minimum no of flower bud/stem (5.5) was found in (C_0T_0) (Table- 6). Similarly (Patel *et al*., 2016), reported that the KNO_3 and thiourea improves flowering and no. of terminal bud the reason behind it is that the favourable effect of foliar application of Thiourea at different freequency promotes ethylene biosynthesis which encourage floral induction and flowering might be due to its bio-regulatory effect chiefly through mobilization of dry matter and translocation of photosynthates to sink (Mishra *et al.*, 2011). The no. of flowerbud increased due to the fact that, exogenous application of thiourea, which stimulated the effect of naturally occurring hormones that accelerated and modified the growth and development of plants which might have increased length of peduncle and thereby number of flower bud/stem.

4.9 Number of flower/Stem

Variation in number of flower/stem was observed among the different treatments under study (Appendix IV). Highest (5.3) number (of flowers/stem was observed in C_3 treatment and the lowest no. of flower/stem (4.5) was observed in C_1 treatment (Table-4). Again from different application frequency highest (6.0) no. of flower /stem was observed at twice (T_2) application of thiourea at 20 and 45 days after transplanting and the lowest (3.6) was observed in T^0 treatment. (Table- 5). Pawar *et al*. (2018) reported that Gladiolus plants treated with thiourea 1% + Salicylic acid 150 ppm recorded significantly maximum length of spike and florets spike^{-1}. Zain *et al.* (2017) was reported he similer result in case of wheat. In case of combination of Concentrations and application frequencies number of flower/stem also exposed significant variation (Appendix IV).The maximum no of flower/stem (6.6) was found in double application and in 1500 ppm concentrations at (C_3T_2) as well as the minimum no of flower/stem (3.6) was found in (C_0T_0) (Table-6). Thiourea application substantially improved the enzymatic and photosynthetic activities. The no. of flower increased due to the fact that, exogenous application of thiourea, which stimulated the effect of naturally occurring hormones that accelerated and modified the growth and development of plants which might have increased length of peduncle and thereby number of flowers/stem.

4.10 Number of flower/plant

Variation in number of flower/plant was observed among the different treatments of lisianthus (Appendix V). Highest number of flowers/plant was observed in C_3 (26.6) and the lowest was observed in C_1 (Table-4). Similar variation was also observed by (Padmalatha *et al*. 2014; Khokhar *et al*., 2016). Again the highest number of flower/plant (30.4) was recorded from T_2 (twice application) at 20 and 45 days after transplanting while lowest number of flower/plant (10.3) was observed in T_0 (control treatment) (Table 5). Similar result was observed by Pawar*et al.* (2018) in case of gladiolous. In case of combination of Concentrations and application frequencies number of flower/plant also exposed significant variation (Appendix V). The maximum no of flower/plant (37.3) was found in double application and in 1500 ppm) concentrations at (C_3T_2) as well as the minimum flower /plant (10.3) were found in (C_0T_0) (Table- 6). Rakesh and Banik (2016) reported same result for mustard. Number of flower buds and flower per stem greatly contributes to the total yield of a plant. Chandroparnik *et al*. (1992) reported that thiourea at the rate of 1500 ppm can increase the number of flower per inflorescence as well as per tree. The effect of various doses and applications frequencies of thiourea was statistically significant .The thiourea with nitrogen and sulfur containing compound accelerate and is being increasing explored for its growth promotion role in plant biologyprocess of tissue differentiationwhich helps in somatic to reproductive, meristematic activity and development of floral primordial , resulting in more flowers was reported by Wahid *et al.* (2017) thiourea not only helps to increase the no. of flower but also improve the others quality of a flower.

4.11 Flower Yield/plot

There were significant differences among the treatments respect to flower yield per plot were highly variation (Appendix V). Foliar spray with thiourea @ 500,1000,1500 ppm followed by different application frequency showed significant variations .In case of different concentrations the highest result (793.2) observed in C_3 where lowest result (472.1) found in C_1. Significantly enhanced yield and also harvest index of clusterbean (Garg *et al*., 2006). From different application frequency maximum no. of flower/plot (898.3) was found from T_2 where minimum result (309.6) was observed in T_0. In case of combined effect of Thiourea concentrations (500,1000, 1500 ppm) and application frequency at 20 and 45 DAT showed significant variation. The highest number of flower/plot (1116.7) was found in C_3 (1500 ppm) and two time application of thiourea (C_3T_2) and and number of flower/plot (309.7) minimum (309.7) was found in C_0T_0.Similer result was reported by (Anitha *et al.,* 2004) for Cowpea. The dormancy breaking effect of thiourea is related to its growth enhancing property and enhancesthe yield of the crops (Germchi *et al.*, 2011)

Table 4. Influences of different concentrations of thiourea on days to flower bud initiation number of flower bud/stem, number of flower/stem, number of flower/plant, fower yield per plot of lisianthus

Treatment	Bud initiation (Days)	Bud number/stem	Flower number/stem	Flower number/plant	Flower yield/plot
C_1	73.7 a	6.8 c	4.5 b	16.0 c	472.1 c
C_2	71.6 b	7.7 b	5.0 ab	22.1 b	651.2 b
C_3	69.1 c	9.2 a	5.3 a	26.6 a	793.2 a
LSD	1.9	0.3	0.5	0.9	9.7
CV%	2.7	4.3	9.9	4.5	1.5

Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500ppm

Table 5. Influences of different application frequency of Thiourea on days to flower bud initiation, number of flower bud/stem, number of flower/stem, number of flower/plant, flower yield per plot of lisianthus

Treatment	Bud initiation (Days)	Bud number/stem	Flower number/stem	Flower number/plant	flower yield/plot
T_0	76.3 a	5.5 c	3.6 c	10.3 c	309.6 c
T_1	70.1 b	8.8 b	5.2 b	24.0 b	708.5 b
T_2	68.1 c	9.4 a	6.0 a	30.4 a	898.3 a
LSD	1.98	0.35	0.50	0.98	9.74
CV%	2.78	4.38	9.98	4.52	1.53

Here, T_0: No thiourea application; T_1: Single application, T_2: Twice application

Table 6. Combined effect of different concentrations and application frequency of thiourea to days to flower bud initiation number of flower bud/stem, number of flower/stem, number of flower/plant, flower yield per plot of lisianthus

Treatment	Bud initiation (Days)	Bud number/stem	Flower number/stem	Flower number/plant	Flower yield/plot
C_0T_0	76.3 a	5.5 f	3.67 d	10.3 f	309.7 g
C_1T_1	73.6 ab	7.4 e	4.6 c	15.3 e	451.7 f
C_1T_2	71.3 bc	7.6 e	5.3 bc	22.3 d	655.0 e
C_2T_1	70.3 bc	8.5 d	5.3 bc	24.3 c	720.7 d
C_2T_2	68.3 cd	9.1 c	6.0 ab	31.6 b	923.3 c
C_3T_1	66.3 de	10.7 b	5.6 b	32.3 b	953.3 b
C_3T_2	64.6 e	11.5 a	6.6 a	37.3 a	1116.7 a
LSD	3.4	0.60	0.8	1.6	16.8
CV%	2.7	4.3	9.9	4.5	1.5

Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm and T_0: No thiourea application; T_1: Single application, T_2: Twice application and C_1T_0, C_2T_0, C_3T_0 treatment combination referred to as C_0T_0

**In a column, means having similar letter (s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.12 Peduncle length

The effect of different application frequencies and concentrations of Thiourea on lisianthus under study influenced the peuncle length in of the flower (Appendix VI). Among the various concentrations the maximum (11.5 cm) peduncle length was found in C_3 (thiourea @ 1500 ppm) and minimum (9.7 cm) was found in C_1 (Table-7). Ruamrungsri *et al*. (2014) mention that different concentrations of nitrogen and phosphorus have positive effect on improving flower stalk length of *Phalaenopsis*. Again the maximum peduncle length (12.7 cm) was recorded from T_2 (twice application) at 20 and 45 days after transplanting while minimum length was (7.7 cm) observed from T_0 (control treatment) (Table- 8). Peduncle length was noted from combined application of thiourea as compared to normal sown crop reported by Asthir *et al.,* (2013). Thiourea 1% + Salicylic acid 150 ppm recorded significantly maximum length of spike in gladiolus was found to be significant by Pawar *et al.,* (2018). In combined effect maximum result was found from (14.1 cm) where minimum (7.7 cm) was observed in (C_0T_0)(Table-9).Thiourea increased accumulation of nutrients especially N, P and S in vegetative parts concomitant the improved metabolism led to greater translocation of these nutrients to reproductive structure of crop reported by Pawar *et al.* (2018). Folier application of thiourea resulted in better utilization of nutrients in soil probably due to the fact that application of thiourea might have helped in improved metabolic process of plants and better growth & development leading to greater absorption of nutrients.

4.13. Peduncle diameter

The difference in treatments under study significant variations was found in diameter of peduncle (Appendix VI). Where, maximum peduncle diameter was recorded (2.4 mm) in C_3 (Thiourea-1500 ppm), and the lowest diameter of peduncle (1.8 mm) was in C_1 (Table-8). Variation in peduncle diameter

due to different concentrations was reported by Rajan *et al.,* (2019) in Chrysanthemum. In case of different application frequency significant variation was observed in the peduncle diameter (Appendix VI). Maximum peduncle diameter was (2.6 mm) recorded in double application of thiourea (T_2) and minimum peduncle diameter (1.5 mm) was found in control treatment (T_0) (Table-8). Sirin (2011) reported that different concentrations of nutrients at certain intervals showed significant result in Gerbera .This is due to the foliar application of thiourea which enhance the metabolic activity of plant. In case of combination of Concentrations and application frequencies maximum (3.1 mm) peduncle diameter was observed in (C_3T_2) where minimum result (1.5 mm) was found from (C_0T_0) (Table-9).

4.14 Receptacle diameter

The difference in treatments under study significant variations was found in receptacle diameter of flowers (Appendix VI). Where, maximum receptacle diameter (6.9 mm) was recorded mm in C_3 (TU-1500 ppm), and the lowest receptacle diameter of stem was (6.2 mm) observed in C_1 (Table-7). Similer result is observed by Sable, *et al*., (2015).In case of different application frequency significant variation was observed in the receptacle diameter (Appendix VI). Maximum diameter was (7.3 mm) recorded in twicee application of thiourea (T_2) and minimum receptacle diameter (5.5 mm) was found in control treatment (T_0) (Table-8).In case of combined effect of thiourea concentrations (500,1000, 1500 ppm) and application frequency at 20 and 45 DAT in lisianthus diameter of receptacle showed significant variation (Appendix VI). The highest diameter (7.8 mm) was found in C_3 (1500 ppm) and two time application of thiourea (C_3T_2) andand minimum stem diameter (5.5 mm) was found in C_0T_0.(Table-9).Nutrient eliments N and S helps in bud development and set and also in formation of different flower parts was reporeted by Rajan *et al.,* (2019) in case of chrysanthemum.

Thiourea is a molecule with two functional groups; ‘thiol’ whichis important to oxidative stress response and ‘imino’ partly fulfils the N requirement and thats are helps in development of different flower parts.

4.15 Flower head diameter

The broadest flower head diameter (6.3 cm) among the different thiourea levels was observed in plots whereas TU levels at (C_3=1500 ppm) was applied in comparison to other concentrations levels of (1000 ppm) and (500 ppm). Maximum result was found from C_3 (6.3) and minimum result found in C_1 (5.1 cm) (Table-7). The broadest flower head diameter among the different S levels was observed in Sunflower by Saleem *et al.* (2019). Flowering diameter was noted maximum (6.5 cm) at twice application of thiourea (T_2) and minimum (4.6 cm) in control (T_0) treatment (Table-8). Similar result was obsearved by Khosa *et al*., (2011) and Sable *et al.*, (2015) in case of gerbera flower .This might be due to increased rate of photosynthesis and enhanced vegetative and reproductive growth of plants. This application of thiourea increase the vigour of lisianthus plants as well as increased the length of cell which caused an increase in diameter of the flower.In case of combination of Concentrations and application frequencies maximum (7.3 cm) flower head diameter was observed in (C_3T_2) where minimum result (4.6 cm) was found from (C_0T_0) (Table-9, Appendix VI). Presence of higher number of flowers is not the only criteria for selection of cut flower. Petal compactness along with a suitable and standard stem length a proper diameter of flower head also contributes to that selection. With increasing supply of sulphur the process of tissue differentiation from somatic to reproductive, meristematic activity and development of floral primordial might have increased, resulting in more flowers and higher yield was reported by Rajan *et al.*, (2019) in Chrysanthemum**.**

4.16 Number of petal/flower

Variation in number of petals/flower was observed among the different level of concentrations. The maximum number of petal/flower (12.6) was recorded from C_3 treatment and minimum (10.5) from C_1 (Table-7). Among different application frequencies of thiourea in lisianthus maximum number of petal/flower (13.5) was recorded from T_2 treatment and minimum (8.6) from T_0 (Table-8).The similar result was reported by Chandroparnik *et al*. (1992). In case of combined effect highest number of petals/flower (15.3) was observed in C_3T_2 and the lowest no.of petal/flower (8.6) was observed in C_0T_0.(Table-9).The no. of petal /flower varied from 8 -15 at different treatments .Petal compactness and brightness of the flower is also very important characteristics for a good cut flower. Thiourea plays a vital role in the physiology of plants both as a sulphydryl compound and to some extent as an amino compound like urea. The stimulating action of thiourea in various physiological activities of plant is well known. It has also been reported Saleem, *et al.*, (2019) that thiourea regulate the plant growth by maintaining higher photosynthetic rate up to the reproductive stage and improve the quality of flower.

Table 7. Influences of different concentrations of thiourea to peduncle length, peduncle diameter, receptacle diameter, flower head diameter, no. of petal/flower of lisianthus

Treatment	Peduncle length (cm)	Peduncle dia. (mm)	Receptacle dia. (mm)	Flower head dia. (cm)	No. of petal/flower
C_1	9.7 c	1.8 c	6.2 c	5.1 c	10.5 b
C_2	10.5 b	2.1 b	6.7 b	5.9 b	11.0 ab
C_3	11.5 a	2.4 a	6.9 a	6.3 a	12.6 a
LSD	0.3	0.1	0.1	0.1	1.0
CV%	2.8	6.3	2.2	3.3	9.4

Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm

Table 8. Influences of different application frequency of thiourea to peduncle length, peduncle dia, receptacle diameter, flower head diameter, no. of petal/flower of lisianthus

Treatment	Peduncle length (cm)	Peduncle dia. (mm)	Receptacle dia. (mm)	Flowerhead dia (cm)	No. of petal/flower
T_0	7.7 c	1.5 c	5.5 c	4.6 c	8.6 c
T_1	11.3 b	2.3 b	7.0 b	6.2 b	12.0 b
T_2	12.7 a	2.6 a	7.3 a	6.5 a	13.5 a
LSD	0.3	0.1	0.1	0.1	1.0
CV%	2.8	6.3	2.2	3.3	9.4

Here, T_0: No thiourea application; T_1: Single application (at 20 days after Transplanting), T_2: Twice application (at 20 and 45 DAT).

Table 9. Combined effect of different concentrations and application frequency of thiourea to peduncle length, peduncle diameter, receptacle diameter, flower head diameter, No. of petal/flower of lisianthus

Treatment	Peduncle length (cm)	Peduncle dia. (mm)	Receptacle dia. (mm)	Flower head dia (cm)	No. of petal/flower
C_0T_0	7.7 e	1.5 f	5.5 f	4.6 e	8.6 e
C_1T_1	10.1 d	1.9 e	6.4 e	5.2 d	10.6 d
C_1T_2	11.3 c	2.1 de	6.8 d	5.4 d	12.3 cd
C_2T_1	11.1 c	2.2 d	7.1 c	6.4 c	11.3 b-d
C_2T_2	12.6 b	2.5 c	7.3 bc	6.7 bc	13.0 bc
C_3T_1	12.7 b	2.8 b	7.5 b	7.0 ab	14.0 ab
C_3T_2	14.1 a	3.1 a	5.5 a	7.3 a	15.3 a
LSD	0.5	0.2	0.2	0.3	1.8
CV%	2.8	6.3	2.2	3.3	9.4

Here, C_1=500 ppm, C_2=1000 ppm, C_3=1500 ppm and T_0: No thiourea application; T_1: Single application (at 20 days after Transplanting), T_2: Twice application (20 and 45 DAT); C_1T_0, C_2T_0, C_3T_0 treatments combination referred to as C_0T_0

** In a column, means having similar letter (s) were statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.17 Colorimetric measurement of lisianthus under different treatments of the study by using CIELab

The colorimetric measurement of the lisianthus under different treatments of the studywere conducted using a precision colorimeter IWAVE WF32 (Shenzhen Wave) and L* (lightness), a* and b* (two Cartesian coordinates) including C* and hab (Chroma & Hue angle) based on CIELab scale with standard observer 100 and standard illumination D65 (CIE, 1986; McGuire, 1992). The respective data for each of the treatments were presented in (Table 10).

Table 10. Variations in petal color attributes in different Treatments

Treatments	L*	a*	b*	c*	h_{ab}
C_1T_1	90.45	15.23	-2.57	15.45	350.42
C_1T_2	80.92	9.79	-1.45	9.89	352.42
C_2T_1	81.36	8.56	-2.73	8.93	350.46
C_2T_2	80.54	9.59	-1.51	9.59	348.25
C_3T_1	89.93	14.54	-2.23	15.73	351.14
C_3T_2	91.67	17.32	-1.78	12.95	350.22
C_0T_0	85.43	15.89	-1.24	16.67	350.67

(a)

(b)

(c)

(d)

Plate 2: (a) Emergence of buds from a single plant (b) Flowers from single plant (c) Harvested flowers (d) Flowers are arranged according to treatments.

C_1T_1

C_1T_2

C_2T_1

C_2T_2

C_3T_1

C_3T_2

C_0T_0

Plate 3: Pictorial presentation of lisianthus, under different treatment combinations**.**

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

5.1 Summary

Lisianthus (*Eustoma grandiflorum*) originated from North America and is widely grown as an ornamental flower in temperate areas. Lisianthus is an excellent cut flower because it contain almost all qualities that are needs to be a good cut flower like as long stem, color variations , extended vase life, non shuttering, appeal and beauty,export potentiality etc. Thats why the demand of lisianthus flower is increasing day by day through the worldwide. Bangladesh has a climate that is particularly favorable for production of lisianthus which can enable us to exploit its high demand and boost our flower industry that has recently started its expansion.

Foliar application of specific nutrients is a method used to improve the efficiency of fertilizer use and increase yields. The increased use of foliar fertilizers in crop production in the last decade is due in part to changes in production philosophy. Foliar-applied nutrients are transported through the phloem and take the pathway of photosynthetic assimilates accelerate the plant quick response. Thiourea enhances the tolerance against stress because of its high water solubility and quick absorption in living tissues. Among the stress alleviating compounds, thiourea is an important molecule with two functional groups; ‘thiol’ is important to oxidative stress response and ‘imino’ partly fulfils the N requirement. It is highly water soluble and easily absorbed in the living tissues.

In order to study the Influence of Thiourea Concentrations and Applications Frequency on Growth and Yield of Light Pink Lisianthus Variety. The experiment was conducted at Horticultural farm, Sher-e-Bangla Agricultural

University, Dhaka during period from November 2018-May 2019 different concentration of thiourea, C_1=0.5 g/L=500 ppm, C_2=1g/L=1000 ppm and C_3=1.5g/L= 1500 ppm. Different Application frequency T_0 (Control, No Thiourea Application) T_1 (Single application, 20 Days after transplanting), T_2 (Twice application, 20 and 45 days after transplanting) was outlined in Completely Randomized Block Design (RCBD) with three replications. Collected data were statistically analyzed for the evaluation of best performance of thiourea at different concentrations level and application frequencies from the following treatments. The findings and conclusion have been described in this segment.

Significant variations were observed in case of thaiourea concentrations as well as application frequency of all parameters are as follows -

The highest plant height was found from C_3 (59.6 cm) and from T_2 (61.3 cm) (twice application) whereas the shortest from C_1 (52.8 cm) and from T_0 (49.0 cm) (No application of thioure). In case of treatment combination, the tallest plant (cm) was found in C_3T_2 (66.1 cm) as well as the shortest plant (49.0 cm) was found in C_0T_0 at 90 DAT.

The maximum number of leaves (67.7) was found from C_3 and minimum (48.8) from C_1 at 80 DAT. The maximum number of leaves (70.6) was found from T_2 and minimum from T_0 (40.6) with 80 days after Transplanting. In case of combined effect, maximum number of leaves (84.6) was found from C_3T_2 and minimum (40.6) from C_0T_0.

Maximum number (4.4) of stem was found in C_3 and minimum (3.2) in C_1. In case of different application frequency of thiourea maximum number of stem (5.0) was found in T_2 and minimum (2.3) in T_0.Combined effect of thiourea concentrations and application frequency maximum number of stem (5.6) was found in C_3T_2 and minimum (2.3) in C_0T_0.

The highest (56.6) chlorophyll content was found from C_3 and minimum (52.5) from C_1.Concidering different application frequency level the highest chlorophyll (59.2) was found from T_2 and minimum from T_0 (47.7). In case of combined effect. In case of combined effect the highest chlorophyll content (62.7) was found from C_3T_2 and minimum (47.7) from C_0T_0.

Among the different concentrations level the the maximum (43.9 cm) stem length was found from C_3 and minimum (38.7 cm) was observed at C_1 .Again in case of application frequency longest stem(38.7 cm) was observed in T_2

treatment where shortest (34.2 cm) was observed in T_0 treatment . In combination effect the best result (51.1cm) was observed C_3T_2 and minimum (34.2 cm) was observed from C_0T_0.

Maximum stem diameter (4.0 mm) was recorded from C_3 where minimum (3.6mm) from C_1.from different application frequency T_2 showed best result. The highest value was found from T_2 (4.3 mm) and minimum from (3.0 mm).The combination between treatments indicated that maximum stem diameter (4.6 mm) was found from C_3T_2 and minimum (3.0 mm) from C_0T_0.

Maximum (73.7 days) required for first flower bud initiation in C_1 where no thiourea was applied and muinimum (69.1 days) was observed from C_3 treatment. similerly best performance(68.1days)was observed in T_2 compared to T_0 treatment (76.3 days). In case of combination effect best result (64.6 days) observed in C_3T_2 and maximum (76.3 days) required in C_0T_0 in first flower bud initiations.

Among the different concentrations level the maximum number of bud /stem (9.2)was found from C_3 and minimum was (6.88) observed at C_1 .Again in case of application frequency maximum bud/stem was observed in T_2 (9.4)and no of bud is treatment where minimum was observed in T_0 (5.5) treatment . In combination effect the best result (11.5) was observed C_3T_2.

Considering the different concentrations level the maximum number of flower/stem (5.3) was observed in C_3 and minimum no. of flower/stem (4.5) was noticed in C_1 and in case of different application frequency level maximum no. of flower/ stem (6.0) is observed in T_2 where minimum no. of flower/stem (3.6) was observed in T_0. and in combination of treatments C_3T_2 showed the best result with maximum no. of flower (6.6) in comparison with minimum result (3.6) found in C_0T_0.

Considering the different concentrations level the maximum number of flower/plant (26.6) was observed in C_3 and minimum no. of flower/plant (16.0) was noticed in C_1 and in case of different application frequency level maximum no of flower/plant (30.4) is observed in T_2 where minimum no. of flower/plant (10.3) was observed in T_0. and in combination of treatments C_3T_2 showed the best result with maximum no. of flower (37.3) in comparison with minimum result (10.3) found in C_0T_0.

Among the different concentrations maximum number of flower/plot (793.2) was observed in C_3 and minimum no. of flower/plant (472.1) was noticed in C_1. In case of different application frequency level maximum no of flower/plant (898.33) is observed in T_2 where minimum no. of flower/plant (309.6) was

observed in T_0. And in combination of treatments C_3T_2 showed the best result with maximum no. of flower (1116.7) in comparison with minimum result (309.7) found in C_0T_0.

Among the different concentrations level the maximum peduncle length (11.5 cm) was found from C_3 and minimum was observed at C_1 (9.7 cm) .Again in case of application frequency longest peduncle length 12.7 cm was observed in T_2 treatment where shortest was observed in T_0 (7.77 cm)treatment . In case of combination effect the best result was observed C_3T_2.

Maximum peduncle diameter (2.4 mm) was recorded from C_3 where minimum (1.8mm) from C_1.from different application frequency T_2 showed best result. The highest value was found from T_2 (2.6 mm) and minimum peduncle diameter from T_0 (1.5 mm) .The combination between treatments indicated that maximum peduncle diameter (3.10 mm) was found from C_3T_2 and minimum (1.5 mm) from C_0T_0.

Maximum receptacle diameter (6.9 mm) was recorded from C_3 where minimum (6.2 mm) from C_1.from different application frequency T_2 showed best result. The highest value was found from T_2(7.3 mm) and minimum receptacle dia from T_0 (5.5mm) .The combination between treatments indicated that maximum receptacle diameter (5.5 mm) was found from C_3T_2 and minimum (5.5 mm) from C_0T_0.

Maximum flower head diameter (6.3 mm) was recorded from C_3 where minimum from C_1 (5.1 mm) among different application frequency T_2 showed best result (6.5). The combination between treatments indicated that maximum stem diameter (7.3mm) was found from C_3T_2 and minimum (4.6 mm) from C_0T_0.

Considering the different concentrations level the maximum number of petal/flower (12.6) was observed in C_3 and minimum no. of petal/flower (10.5) was noticed in C_1 and in case of different application frequency level maximum no of petal/flower (13.5) is observed in T_2 where minimum no. of petal/flower (8.6) was observed in T_0. And in combination of treatments C_3T_2 showed the best result with maximum no. of petal/flower (15.33) in comparison with minimum result (8.6) found in C_0T_0.

5.2 Conclusion

In respect as the above results it can be concluded that lisianthus flower showed significant variations to thiourea. According to result, concentrations (C_3 =1500 ppm) showed tallest plant height, maximum stem number, Maximum leaf number , chlorophyll content, flower number ,flower quality and ultimately the highest yield. On the other hand, concidering the frequency twice application of thiourea performed as excellent. Finally the yield-contributing characters and quality of lisianthus could be improved by application of thiourea at 1500 ppm concentration with twice application frequency performed as the best combination.

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APPENDICES

APPENDICES

Appendix I. Analysis of variance on plant height at different days after transplanting of Lisianthus						
Source of Variation	**Degrees of freedom**	**Mean Square for plant height (cm)**				
		30 DAT	**45 DAT**	**60 DAT**	**75 DAT**	**90 DAT**
Factor A (Thiourea concentration)	2	23.3704*	29.037*	49.779*	47.880*	102.011*
Factor B (Frequency)	2	82.3704*	114.037*	155.121*	288.221*	374.700*
Interaction (A×B)	4	5.9259*	7.620*	12.583*	12.254*	25.603*
Error	16	0.2801	0.419	0.444	0.323	1.886
***: Significant at 0.05 level of probability**						

Appendix II. Analysis of variance on the number of leaves per plant at different days after transplanting of Lisianthus				
Source of Variation	**Degrees of freedom**	**Mean Square for Number of leaves**		
		40 DAT	**60 DAT**	**80 DAT**
Factor A (Thiourea concentration)	2	200.000*	854.52*	803.70*
Factor B (Frequency)	2	618.000*	2314.96*	2191.26*
Interaction (A×B)	4	104.000*	432.59*	209.70*
Error	16	7.111	16.59	5.70
***: Significant at 0.05 level of probability**				

Appendix III. Analysis of variance on the data of Spad Value, branch number per plant, stem length and stem diameter of Lisianthus					
Source of Variation	**Degrees of freedom**	**Mean Square of**			
		SPAD Value	**Number of branches /plant**	**Stem length (cm)**	**Stem dia. (mm)**
Factor A (Thiourea concentration)	2	78.005*	1.4074*	390.258*	0.15663*
Factor B (Frequency)	2	658.934*	672.290*	38.010*	2.03556*
Interaction (A×B)	4	39.850*	7.621*	0.499*	0.03999*
Error	16	50.177	63.115	2.268	0.03305
***: Significant at 0.05 level of probability**					

Appendix IV. Analysis of variance on the data of leaf leangth number of bud/stem, number of flower/stem of Lisianthus				
Source of Variation	**Degrees of freedom**	**Mean Square of**		
		Bud initiation (Days)	**Number of bud/stem**	**Number of flower/stem**
Factor A (Thiourea concentration)	2	49.148*	13.2715*	1.0000*
Factor B (Frequency)	2	165.481*	39.7804*	15.4444*
Interaction (A×B)	4	12.370*	3.3865*	0.6111*
Error	16	3.940	0.1218	0.1944
***: Significant at 0.05 level of probability**				

Appendix V. Analysis of variance on the data of number of petal/flower, number of flower/plant and flower yield/plot of Lisianthus				
Source of Variation	**Degrees of freedom**	**Mean Square of**		
		Number of flower/plant	**Flower yield/plot**	**No. of petal/flower**
Factor A (Thiourea concentration)	2	257.815*	233036*	11.1481*
Factor B (Frequency)	2	949.148	812485*	56.1481*
Interaction (A×B)	4	65.648*	58652*	2.8148*
Error	16	0.954	95	1.1620*
***: Significant at 0.05 level of probability**				

Appendix VI. Analysis of variance on the data of peduncle length, Peduncle diameter, receptacle diameter, flower head diameter of Lisianthus					
Source of Variation	**Degrees of freedom**	**Mean Square of**			
		Peduncle length (cm)	**Peduncle diameter (mm)**	**Receptacle diameter (mm)**	**Flower head diameter (cm)**
Factor A (Thiourea concentration)	2	7.6010*	0.78688*	1.11538*	3.44645*
Factor B (Frequency)	2	58.8108*	2.92748*	8.66327*	9.33900*
Interaction (A×B)	4	1.9233*	0.19807*	0.28562*	0.86345*
Error	16	0.0889	0.01855	0.02238	0.03743
***: Significant at 0.05 level of probability**					