J. Agric. Sci. Mansoura Univ., 31 (6): 3561 - 3592, 2006

EFFECT OF GA_3, NAA AND LIGHT INTENSITY ON MORPHOLOGICAL, ANATOMICAL AND CHEMICAL CHARACTERISTICS OF *GYPSOPHILA* PLANTS.

II- Morphological and anatomical traits.

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ABSTRACT

The field work experiments were carried out during the two successive winter seasons of 2002/2003 and 2003/2004, at the Agricultural Research Station, Faculty of Agriculture, Cairo University, Giza, Egypt. This study aimed to explore the effect of different levels of light intensities (1050, 1800 and 3500 Lux) and foliar applications of GA_3 (0, 250, 500 and 750 ppm) as well as NAA (0, 200, 400 and 600 ppm) on morphological and anatomical characters of shoots and roots of two *Gypsophila* species; *G.paniculata* and *G.elegans*. Results on morphological and productive characters indicated that, the best stimuli combination to get highest plant height in *G.paniculata* was with the plants treated by foliar application at 250 ppm GA_3, grown under 3500 Lux light intensity, and at 500 ppm GA_3 under the same Lux In case of *G.elegans*. While, in case of using NAA as foliar application, the 200 ppm under 1800 Lux light intensity caused an increase the plant height *of G.paniculata*. In *G.elegans*, the 400 ppm NAA under 3500 Lux represented the same result. It was also found that, the best stimuli combination for scoring the highest average number of first order branches/plant in *G.paniculata* was 250 ppm GA_3, grown under 3500 Lux light intensity. In case of *G.elegans*, it was 400 ppm NAA grown under 1800 Lux. Plants of *G.paniculata* treated with 250 ppm GA_3 under 3500 Lux light intensity and plants of *G.elegans* with 500 ppm GA_3 under 1800 Lux exhibited the greatest number of simple inflorescences/plant compared with the other treatments. Both NAA concentrations; 200 ppm with 1050 Lux and 400 ppm with 1800 Lux caused the same result mentioned above with *G.paniculata* and *G.elegans*, respectively.

Plants of *G.paniculata*, exposed to the 3500 Lux light intensity, exhibited full blooming at 20 and 35.5 days earlier than those subjected to the other two light intensities (1800 and 1050 Lux). Plants of *G.elegans*, exposed to the same light intensity, substantiated full blooming at 16 and 31 days earlier than those subjected to the other two light intensities. Moreover, these plants treated by GA_3 at 250 ppm and 200 ppm NAA under 3500 Lux showed the earliest full blooming among the other treatments.

In both species, the anatomical studied proved that, plants adapted to NAA applications under 3500 Lux light intensity exhibited an increase of all the diameter measurements of root, stem and leaf. These increments due to an increase of all root, stem and leaf internal tissues. On the contrary, GA3 treatments with 3500 Lux light intensity produced narrow xylem vessels of root and stem. As well as these treatments caused an increase of root diameter and decrease in stem one and leaf blade measurements.

INTRODUCTION

Genus of *Gypsophila* is comprise some 125 species belongs to family Cariophyllaceae. All species are suitable for gardens except *G.paniculata* L., whose varieties are popular and commercially suitable for cut flowers (Anon 1997). *Gypsophila* plants have weak apical dominance, when the plant grow

is stimulated by long-day conditions, the stem elongates and terminates in blooming. Under short-day conditions accompanied with low temperatures, the plant terminated in a rosette-shaped of leaves. According to its growth pattern, *Gypsophila* is defined as an obligatory and quantitative long-day plant. This meant that long-day conditions encourage the plant to proceed from the vegetative to the flowering stage. So, it could be concluded that day length, temperature and light intensity affect plant growth stages and are crucial at the stages of bolting and flower inductions (initiation and formation of flowering buds). One of the major facts for *Gypsophila* production as cut flowers is that; the plant under short-day condition will be characterized by vegetative growth with more branches and rare flowers. Lighting is very important factor in *Gypsophila* cultivation. For this reason, artificial lighting at suitable intensity is necessary for growth, with some cautions, hence the early artificial lighting will promote poor production (Zimmer, 1982).

Growth regulators are organic substances which influence, at various concentrations, the plant physiological processes as growth, differentiation and development. Gibberellins mainly caused hyper elongation of stems by stimulating both cell division and cell elongation. It is also used for bolting in long-day plants as well enhancement of flower bud formation (Anon, 1997). The gibberellins (GA_3) are a large family of diterpene acids. They were originally isolated as metabolites of the fungus *Fusarium moniliforme,* the imperfect stage of *Gibberella fujikuroi* and were shown to cause a wide rang of often spectacular growth responses when applied to intact plants. The GA_3 is now known to be of widespread, and probably universal, occurrence in higher plants where they are generally accepted to function as hormones. The GAs from higher plants have been chemically identified in 28 species representing 11 families predominantly angiosperms. An even wider distribution is indicated by the presence of GA-like biological activity in plant extracts and could be record GA-like substances in 130 species of angiosperms and 9 species of gymnosperms. The effect of GAs is not confined to the angiosperms. In many plant species, GAs promotes shoot elongation and flowering (Wilkins, 1984). NAA compounds are used for the resemblance with IAA in action, but are resistant to degradation by plant enzyme. On the main time, as far as the authors were aware no details study dealing with NAA effects on *Gypsophila* plants was found.

This study aimed to explore the effect of different levels of light intensities and foliar applications by GA_3 and NAA on morphological and anatomical traits of two *Gypsophila* species *G.paniculata* L. and *G.elegans* M.Bieb. As well as, to propose the suitable technique for producing one of the most important cut flowers.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive winter seasons of 2002/2003 and 2003/2004, at the Agricultural Research Station, Faculty of Agriculture, Cairo University, Giza, Egypt, on *Gypsophila* transplants, namely; *G.paniculata* L. (perennial) and *G.elegans* M.Bieb. (annual). These transplants were imported from Merstema Laboratory, Italy

and were planted at 10th October, 2002 in the first season and 15th October 2003 in the second one. The Experimental layout was split plot design with three replicates. Light intensities treatments were adopted by hanging electric bulbs lamps above each experimental split plot. Light intensity for each sub plot was calibrated using Lux-meter model (Testoterm 0500 supplemented by Silicon photo cell for precision measurements, part no. 0560.0500) for insuring the implement of the three light intensities; 1050, 1800 and 3500 Lux. Photoperiod received was 16/8 h light/dark .

Growth regulators treatments were performed in the field by foliar applications of two plant growth regulators. These regulators were Gibberellic acid (GA_3) (Accel® with 1ga.i, Valent Biosciences Corp) was applied at the rates of 0, 250, 500 and 750 ppm and Naphthalene acetic acid (NAA) (99% purity, Emerk, Darmstadt, Germany) was applied at the rates of 0, 200, 400 and 600 ppm.

All field practices were carried out as recommended for the commercial production of *Gypsophila* plants. According to the experimental design each main plot was adopted to the three levels of light intensities. Each sub-plot was split into two adopted growth regulators with four concentrations each. Plants aged 30 days after transplanting (DAT) were decapitated at height of 10 cm and sprayed by gibberellic acid (GA_3) with the four concentrations individually as well as naphthalene acetic acid (NAA) with the four concentrations individually. Data were recorded two weeks intervals on three plants from each replicate (nine records representing each experimental treatment). The studied morphological characters were; plant height (cm), average number of first order branches/plant, average number of simple cymose inflorescences/plant calculated during blooming stage and average number of days till flowering date calculated as average number of days elapsed from punching to flowering date.

Data obtained from each treatment were analyzed on mean plot basis as each split plot was adopted with 3 replicates, data of morphological traits was statistically analyzed through a computer software (MSTAT, 1986).

Four random plants per each treatment for the two studied species where subjected two anatomical studied at full blooming stage during the second season. These involved the internal structures of stem and root, as well the foliage leaf of the plants grown under 3500 Lux light intensity. The investigated specimens included the following:

- The intermediate portion of the 4th internode from the tip of the first order branch.
- The blade of fully unfolded leaf at the 4th node from the tip of the first order branch.
- The fibrous root at its basal end.

Microtechnique procedures were carried out according to Nassar and El-Sahhar (1998).

RESULTS AND DISCUSSIONS

Effect of light intensities and growth regulators on the plant morphological traits.

1- Plant height

Data referred to the effective of the studied treatments on average plant height of both studied *Gypsophila* species are presented in Tables (1&2). It is obvious that statistical analysis proved significant effects of; levels of light intensities, types and concentrations of growth regulators GA_3 and NAA along with plant age. The interactions between these treatments were also significant.

It is clear that, the untreated plants of *G.paniculata* exhibited stunted growth showed unusual vegetative growth along with plant age as compared with normal plant of the other species *G.elegans*.

Concerning light intensities effects, in both species, it is evident that, 3500 Lux light intensity produced the tallest plants as compared with those exposed to the other two light intensities. So, it could be stated that increasing light intensity was commonly accompanied by increasing plant height, where, the percentages of plant height were 12.2 and 16.1% with 3500 Lux for *G.paniculata* and *G.elegans*, respectively. It is evident that, in both studied species, the interactions between the used growth regulators and levels of light intensities significantly affected the mean plant height. In which, plants of *G.paniculata*, treated with GA_3 and exposed to 3500 Lux showed the tallest plants as compared with the other two used light intensities. Since, the averages plant height of such treatments combined with GA_3 were; 54.6, 45.2 and 44.0 cm for the three used light intensities in descending order. Contrary, plants treated with NAA and exposed to 3500 Lux showed average plant height of 17.6 cm compared with the other two light intensities (1800 and 1050 Lux) that produced tall plants, scored 21.9 and 18.2 cm for 1800 and 1050 Lux light intensities, respectively. *G.elegans* showed another response towards the interactions between light intensities and growth regulator treatments. In which, both GA_3 and NAA treatments seemed to affect the mean plant height with relatively same magnitude. Plants exposed to 3500 Lux and sprayed with either GA_3 or NAA showed the tallest plant height as compared with the other two light intensities.

Regarding the effects of growth regulator treatments, data presented in Tables (1&2) proved that, *G.paniculata* plants treated with GA_3 showed appreciable increase in mean plant height as compared with NAA treatments with the three used light intensities where; 141.7, 106.3 and 210.2% for plants treated with GA_3 and NAA and grown under 1050, 1800 and 3500 Lux light intensities, respectively. The other species *G.elegans* showed similar trend with relatively low extent. Wherein, the average increased percentages of mean plant height due to GA_3 treatments compared with NAA treatments under the three used light intensities were; 13.1, 12.1 and 27.5% for plants treated with GA_3 and NAA and grown under light intensities of 1050, 1800 and 3500 Lux, respectively. With respect to dose effects, relative to the control, all GA_3 and NAA concentrations caused an increase in plant height with different extents.

Table (1): The average of plant height of *G.paniculata* as affected by GA_3 and NAA under different levels of light intensities. (Pooled data of two successive winter seasons 2002/2003 and 2003/2004).

Light Intensity	1050 Lux										
Growth Reg.	GA3					NAA					
Concentrations Age (weeks)	0	250	500	750	Av. GA3XL.	0	200	400	600	Av. NAAXL	Av.TreatXL
5	12.2	15.1	17.8	18.3	**17.1**	12.2	13.1	12.4	12.0	**12.5**	**14.8**
7	12.8	25.2	27.1	28.8	**27.0**	12.8	15.5	14.1	13.5	**14.4**	**20.7**
9	13.5	30.2	35.7	37.1	**34.3**	13.5	16.1	15.3	14.6	**15.3**	**24.8**
11	13.9	36.8	39.8	42.8	**39.8**	13.9	17.8	15.9	15.2	**16.3**	**28.1**
13	14.2	41.5	44.4	49.5	**45.1**	14.2	20.1	18.5	16.6	**18.4**	**31.8**
15	15.3	48.3	49.7	52.2	**50.1**	15.3	22.5	19.3	17.6	**19.8**	**35.0**
17	15.9	52.6	55.2	59.1	**55.6**	15.9	24.3	20.4	18.9	**21.2**	**38.4**
19	16.1	57.4	59.8	64.3	**60.5**	16.1	25.1	21.2	20.2	**22.2**	**41.4**
21	16.6	60.1	65.3	74.6	**66.7**	16.6	25.5	22.7	22.8	**23.7**	**45.2**
Av.Treatments	**14.5**	**40.8**	**43.9**	**47.4**	**44.0**	**14.5**	**20.2**	**17.7**	**16.7**	**18.2**	**31.1**
verage Light1050	**27.0**										
	1800 Lux										
5	12.0	19.2	21.0	21.3	**20.5**	12.0	14.2	13.5	13.1	13.6	**17.1**
7	12.5	27.2	29.5	30.1	**28.9**	12.5	17.3	15.2	14.8	15.8	**22.4**
9	12.9	29.8	31.5	33.2	**31.5**	12.9	20.1	18.6	16.5	18.4	**25.0**
11	13.4	34.4	38.4	41.1	**38.0**	13.4	21.9	19.6	17.7	19.7	**28.9**
13	13.8	40.2	44.5	49.2	**44.6**	13.8	27.5	21.5	19.1	22.7	**33.7**
15	14.5	45.5	48.8	53.4	**49.2**	14.5	29.9	22.8	21.1	24.6	**36.9**
17	14.9	51.6	55.5	61.1	**56.1**	14.9	33.3	23.9	22.6	26.6	**41.4**
19	15.1	58.8	62.5	69.8	**63.7**	15.1	33.4	24.3	22.9	26.9	**45.3**
21	15.2	65.3	77.5	81.3	**74.7**	15.2	37.5	25.9	23.4	28.9	**51.8**
Av.Treatments	**13.8**	**41.3**	**45.5**	**48.9**	**45.2**	**13.8**	**26.1**	**20.6**	**19.0**	**21.9**	**33.6**
erage Light1800	**28.6**										
	3500 Lux										
5	12.2	21.6	20.8	20.1	20.8	12.2	13.5	12.8	12.9	**13.1**	**17.0**
7	12.4	24.2	27.5	25.8	25.8	12.4	14.4	13.1	13.7	**13.7**	**19.8**
9	12.5	38.4	34.4	31.5	34.8	12.5	14.9	14.5	15.2	**14.9**	**24.9**
11	12.7	45.9	41.1	38.6	41.9	12.7	15.2	15.5	16.3	**15.7**	**28.8**
13	12.8	59.6	55.3	42.3	52.4	12.8	15.8	16.1	17.4	**16.4**	**34.4**
15	13.1	72.8	60.8	49.4	61.0	13.1	16.6	17.2	19.6	**17.8**	**39.4**
17	13.2	86.4	71.5	62.5	73.5	13.2	17.3	19.3	24.2	**20.3**	**46.9**
19	13.4	95.2	82.6	74.5	84.1	13.4	17.8	22.5	27.3	**22.5**	**53.3**
21	13.5	**105**	96.7	90.1	97.3	13.5	18.9	23.4	28.9	**23.7**	**60.5**
Av.Treatments	**12.9**	**61.0**	**54.5**	**48.3**	**54.6**	**12.9**	**16.0**	**17.2**	**19.5**	**17.6**	**36.1**
erage Light3500	**30.3**										
	Combined Data										Av. Age
5	12.1	18.6	19.9	19.9	19.5	12.1	13.6	12.9	12.7	13.1	16.3
7	12.6	25.5	28.0	28.2	27.2	12.6	15.7	14.1	14.0	14.6	21.0
9	13.0	32.8	33.9	33.9	33.5	13.0	17.0	16.1	15.4	16.2	24.9
11	13.3	39.0	39.8	40.8	39.9	13.3	18.3	17.0	16.4	17.2	28.6
13	13.6	47.1	48.1	47.0	47.4	13.6	21.1	18.7	17.7	19.2	33.3
15	14.3	55.5	53.1	51.7	53.4	14.3	23.0	19.8	19.4	20.7	37.1
17	14.7	63.5	60.7	60.9	61.7	14.7	25.0	21.2	21.9	22.7	42.2
19	14.9	70.5	68.3	69.5	69.4	14.9	25.4	22.7	23.5	23.9	46.7
21	15.1	76.8	79.8	82.0	79.6	15.1	23.2	20.6	21.4	25.4	52.5
Av.Treatments	**13.7**	**47.7**	**48.0**	**48.2**	**47.9**	**13.7**	**20.8**	**18.5**	**18.4**	**19.2**	**33.6**

$LSD_{5\%}$ Light =0.6
$LSD_{5\%}$ Treatment =8.2
$LSD_{5\%}$ Age =1.8
$LSD_{5\%}$ Concentration =0.4
$LSD_{5\%}$ Light X Treat X Age =0.2
$LSD_{5\%}$ Treatment X Light =0.4
$LSD_{5\%}$ Age X Treatment =1.2
$LSD_{5\%}$ Treat. X Light X Conc. = 0.3

Table (2): The average of plant height of *G.elegans* as affected by GA_3 and NAA under different levels of light intensities.(Pooled data of two successive winter seasons 2002/2003 and 2003/2004) .

Light Intensit y	1050 Lux									
Growth Reg.	GA3					NAA				
Concentrations Age (Days)	0	250	500	750	Av. GA3XL.	0	200	400	600	Av. NAAXL	Av.TreatXL
5	13.4	15.6	18.5	18.9	**17.7**	13.4	13.1	13.4	13.8	13.4	**15.6**
7	21.2	24.2	28.4	30.2	**27.6**	21.2	19.8	20.2	22.5	20.8	**24.2**
9	29.9	30.5	35.1	39.3	**35.0**	29.9	28.4	32.4	35.2	32.0	**33.5**
11	35.4	34.5	38.5	44.5	**39.2**	35.4	32.5	36.3	39.4	36.1	**37.7**
13	42.6	40.1	45.6	52.3	**46.0**	42.6	40.6	42.8	45.5	43.0	**44.5**
15	51.2	47.7	55.1	61.7	**54.8**	51.2	45.5	50.1	52.1	49.2	**52.0**
17	60.5	53.2	65.8	70.2	**63.1**	60.5	52.3	55.6	59.8	55.9	**59.5**
Av.Treatments	**36.3**	**35.1**	**41.0**	**45.3**	**40.5**	**36.3**	**33.2**	**35.8**	**38.3**	**35.8**	**38.2**
AverageLight1050	**37.3**										
	1800 Lux										
5	13.8	19.2	21.0	21.3	20.5	13.8	13.2	13.5	14.1	13.6	**17.1**
7	22.2	26.8	33.2	33.2	31.1	22.2	19.5	25.6	27.5	24.2	**27.7**
9	30.5	33.4	39.1	45.2	39.2	30.5	27.3	36.5	39.5	34.4	**36.8**
11	37.1	39.7	43.6	58.4	47.2	37.1	34.8	42.5	47.8	41.7	**44.5**
13	44.3	43.2	52.9	67.5	54.5	44.3	41.0	51.2	53.2	48.5	**51.5**
15	53.5	49.5	60.3	75.4	61.7	53.5	48.6	60.4	61.6	56.9	**59.3**
17	61.0	55.3	72.6	81.5	69.8	61.0	54.6	69.5	70.4	64.8	**67.3**
Av.Treatments	**37.5**	**38.2**	**46.1**	**54.6**	**46.3**	**37.5**	**34.1**	**42.7**	**44.9**	**41.3**	**43.8**
AverageLight1800	**42.0**										
	3500 Lux										
5	14.1	21.6	20.8	20.1	20.8	14.1	13.5	13.8	12.9	13.4	**17.1**
7	24.5	29.2	35.9	32.4	32.5	24.5	22.2	28.5	20.1	23.6	**28.1**
9	32.4	37.5	51.5	40.5	**43.2**	32.4	31.5	40.2	28.5	33.4	**38.3**
11	39.2	48.3	62.6	49.2	**53.4**	39.2	39.8	51.4	35.6	42.3	**47.9**
13	47.1	54.3	73.4	55.2	**61.0**	47.1	45.8	58.4	42.5	48.9	**55.0**
15	58.3	62.2	84.3	60.1	**68.9**	58.3	50.6	65.6	48.9	55.0	**62.0**
17	62.4	74.3	91.5	65.8	**77.2**	62.4	65.5	72.1	53.5	63.7	**70.5**
Av.Treatments	**41.3**	**46.8**	**60.0**	**46.2**	**51.0**	**41.3**	**38.4**	**47.1**	**34.6**	**40.0**	**45.5**
AverageLight3500	**44.5**										
	Combined Data										Av. Age
5	13.8	18.8	20.1	20.1	19.7	13.8	13.3	13.6	13.6	13.5	16.6
7	22.6	26.7	32.5	31.9	30.4	22.6	20.5	24.8	23.4	22.9	26.7
9	30.9	33.8	41.9	41.7	39.1	30.9	29.1	36.4	34.4	33.3	36.2
11	37.2	40.8	48.2	50.7	46.6	37.2	35.7	43.4	40.9	40.0	43.4
13	44.7	45.9	57.3	58.3	53.8	44.7	42.5	50.8	47.1	46.8	50.3
15	54.3	53.1	66.6	65.7	61.8	54.3	48.2	58.7	54.2	53.7	57.8
17	61.3	60.9	76.6	72.5	70.0	61.3	57.5	65.7	61.2	61.5	65.8
Av.Treatments	**38.4**	**40.0**	**49.0**	**48.7**	**45.9**	**38.4**	**35.2**	**41.9**	**39.3**	**39.0**	**42.5**

$LSD_{5\%}$ Light =1.0
$LSD_{5\%}$ Treatment =2.4
$LSD_{5\%}$ Age =1.8
$LSD_{5\%}$ Concentration =0.4
$LSD_{5\%}$ Light X Treat X Age =0.4
$LSD_{5\%}$ Treatment X Light =0.3
$LSD_{5\%}$ Age X Treatment =0.12
$LSD_{5\%}$ Treat. X Light X Conc. =0.3

Linear relationships could be found between GA_3 concentrations plant height increasing ranges. Consequently, the average increased percentages in plant height in *G. paniculata* plants due to GA_3 250, 500 and 750 ppm were; 248.1, 250.3 and 251.8%, respectively. The corresponding values due to same GA_3 concentrations of *G.elegans* were; 4.1, 27.6 and 26.8% as arranged in the

same order. Thus, it is worthy to mention that GA_3 treatments are more reliable and efficient to induce tallest plants of *G.paniculata*. Nevertheless, on GA_3 treatments *G.elegans*, may show minute effects as a tool for inducing remarkably tall plants. Generally, in both species, the most effective foliar GA_3 concentration treatment for inducing the tallest plants was 750 ppm. The relationship between NAA concentrations and the resultant plant height was dissimilar than in case of GA_3. Like, the NAA concentration increased the shortest plant was occurred. Wherein, relative to the control, the low NAA concentration 200 ppm, seemed to be more efficient for inducing tallest plants. Consequently, the average increased percentages in plant height of *G. paniculata* plants due to NAA treatments (200, 400 and 600 ppm) were; 51.8, 35.0 and 34.3%, respectively. The corresponding amounts due to same NAA concentrations in *G.elegans* were; -8.3, 9.1 and 2.3% as arranged in the same order. This indicated that using NAA as growth stimuli for plant height, within *G.elegans* is not efficient enough and generally NAA treatments may depress the average plant height.

Regardless the light intensity, interaction between all studied treatments was significant. So, it could be concluded that, the best stimuli combination to get tallest plants in *G.paniculata* was with the plants treated by foliar application GA_3 at 750 ppm grown under 3500 Lux light intensity and harvested at the age of 19-21 weeks. In case of *G.elegans*, it is evident that, NAA treatments relatively do not affect the mean plant height with appreciably great extent. Generally, plants treated by foliar application GA_3 at 500 ppm, grown under 3500 Lux light intensity, and harvested at the age of 15-17 weeks from transplanted scored the highest plant height.

It is evident from the abovementioned results that, growth regulators GA_3 and NAA are less effective when reducing light intensity companied with many other treatments; i.e., temperature, soil humidity and nitrogen supply. The direct effect of GA_3 of inducing tallest plants was reported before by many workers; Stowe and Yamaki (1959) stated that the most striking effect of spraying plants with gibberellin is the growth stimulation. Stems of the sprayed plants usually become much longer than the normal one. Growth is stimulated in the younger internodes and tissues, and frequently the length of the individual internodes is increased while the number of internodes remains unchanged. The results of the present study dealing with effects of different levels of light intensities and GA_3 were strongly supported by the findings reported earlier by Karaguzel (1996) and Davies *et al.,* (1996), Karaguzel and Altan, (1999) and Hwang *et al.,* (2003).

Regarding the effect of NAA, it is evident that, the uses of synthetic auxins can be traced directly to the roles of IAA in plant. So, compounds such as NAA are used because they are resemble to IAA action but are resistant to degradation by plant enzymes. On the main time, as far as the authors were aware no detailed study dealing with NAA effects on *Gypsophila* plant was carried out. However, on other Caryophyllaceae genera, Sonvir-Sooch *et al.*, (2002) stated that, carnation plants cv. Corolla were sprayed by NAA which significantly increased plant height. Moreover, on other genus *Chrysanthemum*, belongs to Asteraceae many workers reported that, GA_3 treatments at the rate of 1000 ppm for three times, increased stem elongation

of non-vernalized plants under both short and long-days, while flower formation was achieved only in the plants subsequently grown under short-day conditions. Zimmer (1982), on *Chrysanthemum morifolium* cvs. Brigitte and *Asta* concluded that spraying non-vernalized plants with GA3 at the rates up to 500 ppm had no substituting effect on flowering although some shoot elongation was occurred.

2- Average number of first order branches/ plant

Data of the average number of first order branches per plant are presented in Tables (3&4). All treatments under study; light intensities, types and concentrations of growth regulators GA_3 and NAA as well as plant age affected the average number of first order branches per plant alone or linked up with each other. As well, the interactions between the studied treatments were also significant. It was noticed that, the untreated plants of *G.paniculata* showed delayed bolting stage. Since, plants started to perform a considerable number of branches after 11 weeks from transplanting. Contrary, *G.elegans* started bolting stage earlier 7 weeks after transplanting.

With regard to light intensities effects, it is evident that, in both species, plants exposed to 3500 Lux showed high number of branches/plant as compared with those exposed the other two light intensities. So, it could be stated that increasing light intensity was accompanied with increasing the average number of 1st order branches per plant. The increased percentages in number of branches per plant owing to the highest level of light intensity 3500 Lux as compared with the lower one 1050 Lux, where they were 22.3 and 8.8% for *G.paniculata* and *G.elegans*, respectively.

It is realized that, in both studied species, the interactions between the used growth regulators and levels of light intensities significantly affected the mean number of first order branches. Where, plants of *G.paniculata*, treated with GA_3 and exposed to 3500 Lux showed more branches per plants as compared with the other two used light intensities. The average numbers were 15.6, 12.8 and 11.1 branches per plant, respectively. Moreover, plants treated by NAA showed another trend. Wherein, the mean number of branches for plant treated with (1050 Lux) was 7.2 branches compared with the other two light intensities 1800 and 3500 Lux that produced less branched plants, 6.7 and 6.4 first order branch per plant. The response of the other species *G.elegans* towards the interactions between light intensities and growth regulator treatments showed another response. Since, plants exposed to 3500 Lux and treated with GA_3 showed more branches as compared with the other two light intensities. Similarly, those treated with NAA and exposed to 1800 Lux.

Concerning concentrations effects, relative to the control, all GA_3 and NAA concentrations caused an increase in number of first order branches per plant with different extents. Therefore, the average increased percentages in number of branches per plant of *G.paniculata* due to GA_3 concentrations 250, 500 and 750 ppm were; 238.8, 266.6 and 291.6 %, respectively. The corresponding amounts due to same concentrations on *G.elegans* were; 5.9, 13.4 and 11.9%, ranked in the same order. Thus, it is worthy to mention that, GA_3 treatments are relatively more reliable and efficient for inducing high number of first order branches in *G.paniculata* than in *G.elegans*.

Table (3): The average number of first order branches of *G.paniculata* as affected by GA_3 and NAA under different levels of light intensities. (Pooled data of two successive winter seasons 2002/2003 and 2003/2004).

Light Intensity	1050 Lux									
Growth Reg.	GA3					NAA				
Concentrations Age (weeks)	0	250	500	750	Av. GA3XL.	0	200	400	600	Av. NAAXL	Av.TreatXL
5	2.2	5.1	5.4	5.8	**5.4**	2.2	4.2	3.6	3	**3.6**	4.5
7	2.5	7.6	7.9	8.4	**8.0**	2.5	5.5	5.1	4.6	**5.1**	6.6
9	2.6	9.2	12.1	12.6	**11.3**	2.6	6.9	6.5	6	**6.5**	8.9
11	2.9	9.3	13.2	13	**11.8**	2.9	8.6	7.5	7.2	**7.8**	9.8
13	3.2	9.5	13.4	13.6	**12.2**	3.2	8.8	7.7	7.5	**8.0**	10.1
15	3.3	9.6	13.8	13.9	**12.4**	3.3	9.1	8	7.9	**8.3**	10.4
17	3.3	9.6	14	14.3	**12.6**	3.3	9.2	8.2	7.9	**8.4**	10.5
19	3.4	9.7	14.1	15.1	**13.0**	3.4	9.3	8.3	8	**8.5**	10.8
21	3.5	9.8	14.2	15.3	**13.1**	3.5	9.3	8.3	8	**8.5**	10.8
Av.Treatments	3.0	**8.8**	**12.0**	**12.4**	**11.1**	3.0	**7.9**	**7.0**	**6.7**	7.2	9.2
AverageLight1050	**7.6**										
	1800 Lux										
5	3	6.2	7.6	7.9	**7.2**	3	4.9	4	3.8	**4.2**	5.7
7	3.2	8.5	9.4	10.2	**9.4**	3.2	5.2	4.8	4.5	**4.8**	7.1
9	3.4	10.2	11.9	14.9	**12.3**	3.4	5.5	5.3	4.9	**5.2**	8.8
11	3.5	11.2	12.6	16.8	**13.5**	3.5	6.5	6	5.3	**5.9**	9.7
13	3.6	11.6	13.2	17.3	**14.0**	3.6	7.6	6.9	6.2	**6.9**	10.5
15	3.8	11.7	13.3	17.9	**14.3**	3 8	9	7.6	7	**7.9**	11.1
17	4	11.8	13.5	17.9	**14.4**	4	9.6	7.8	7.4	**8.3**	11.4
19	4.4	11.9	14.4	19.1	**15.1**	4.4	9.8	8	7.8	**8.5**	11.8
21	4.4	11.9	14.4	19.2	**15.2**	4.4	**10**	8.6	8.2	**8.9**	12.1
Av.Treatments	**3.7**	**10.6**	**12.3**	**15.7**	**12.8**	**3.7**	**7.6**	**6.6**	**6.1**	6.7	9.8
AverageLight1800	**8.3**										
	3500 Lux										
5	2.8	6.1	6	8.6	**6.9**	2.8	4.8	3.9	3.8	**4.2**	5.6
7	3.3	12.3	11.8	11.4	**11.8**	3.3	5.1	4.5	4.2	**4.6**	8.2
9	3.6	15.5	15.2	14.2	**15.0**	3.6	5.9	4.9	4.7	**5.2**	10.1
11	3.8	18.9	16.5	15.1	**16.8**	3.8	6.2	5.8	5	**5.7**	11.3
13	4.5	20.1	17.2	15.4	**17.6**	4.5	7.1	6.6	5.8	**6.5**	12.1
15	4.6	20.2	17.4	15.5	**17.7**	4.6	8.5	7.2	6.6	**7.4**	12.6
17	4.7	20.5	17.8	15.6	**18.0**	4.7	8.7	7.5	7.1	**7.8**	12.9
19	4.9	20.6	18	15.8	**18.1**	4.9	8.9	7.9	7.7	**8.2**	13.2
21	5	**20.9**	18.4	16.1	**18.5**	5	9.2	8	7.8	**8.3**	13.4
Av.Treatments	**4.1**	**17.2**	**15.4**	**14.2**	**15.6**	**4.1**	**7.2**	**6.3**	**5.9**	**6.4**	11.0
AverageLight3500	**9.3**										
	Combined Data										Av. Age
5	2.7	5.8	6.3	7.4	6.5	2.7	4.6	3.8	3.5	4.0	5.3
7	3.0	9.5	9.7	10.0	9.7	3.0	5.3	4.8	4.4	4.8	7.3
9	3.2	11.6	13.1	13.9	12.9	3.2	6.1	5.6	5.2	5.6	9.3
11	3.4	13.1	14.1	15.0	14.0	3.4	7.1	6.4	5.8	6.5	10.3
13	3.8	13.7	14.6	15.4	14.6	3.8	7.8	7.1	6.5	7.1	10.9
15	3.9	13.8	14.8	15.8	14.8	3.9	8.9	7.6	7.2	7.9	11.4
17	4.0	14.0	15.1	15.9	15.0	4.0	9.2	7.8	7.5	8.2	11.6
19	4.2	14.1	15.5	16.7	15.4	4.2	9.3	8.1	7.8	8.4	11.9
21	4.3	14.2	15.7	16.9	15.6	4.3	9.5	8.3	8.0	8.6	12.1
Av.Treatments	3.6	12.2	13.2	14.1	13.2	3.6	7.6	6.6	6.2	6.8	10.0

$LSD_{5\%}$ Light =0.6
$LSD_{5\%}$ Treatment =3.1
$LSD_{5\%}$ Age =0.2
$LSD_{5\%}$ Concentration =0.5

$LSD_{5\%}$ Light X Treat X Age =0.3
$LSD_{5\%}$ Treatment X Light =0.4
$LSD_{5\%}$ Age X Treatment =0.2
$LSD_{5\%}$ Treat. X Light X Conc. =1.3

Table (4): The average number of first order branches of *G.elegans* as affected by GA_3 and NAA under different levels of light intensities.(Pooled data of two successive winter seasons 2002/2003 and 2003/2004).

Light Intensity	1050 Lux										
Growth Reg.	GA3					NAA					
Concentrations Age (weeks)	0	250	500	750	Av. GA3XL.	0	200	400	600	Av. NAAXL	Av.TreatXL
5	3.7	4.1	4.4	4.2	**4.2**	3.7	3.8	3.9	4.1	**3.9**	4.1
7	5.5	5.8	6.1	6.5	**6.1**	5.5	5.6	6.3	6.5	**6.1**	6.1
9	6.1	7.0	7.2	7.7	**7.3**	6.1	7.3	7.5	7.4	**7.4**	7.4
11	6.7	7.3	7.6	8.1	**7.7**	6.7	7.8	8.4	7.9	**8.0**	7.9
13	6.9	7.5	7.9	8.5	**8.0**	6.9	8.1	8.9	8.1	**8.4**	8.2
15	7.1	7.7	8.2	8.7	**8.2**	7.1	8.3	9.1	8.6	**8.7**	8.5
Av.Treatments	6.0	**6.6**	**6.9**	**7.3**	**6.9**	6.0	**6.8**	**7.4**	**7.1**	7.1	7.0
verage ght1050	**6.8**										
1800 Lux											
5	3.9	4.8	5.5	5.1	**5.1**	3.9	4.1	4.4	4.2	**4.2**	4.7
7	6.2	6.3	7.1	7.4	**6.9**	6.2	6.5	6.8	5.9	**6.4**	6.7
9	7.3	7.2	7.9	8.1	**7.7**	7.3	7.7	8.4	7.1	**7.7**	7.7
11	7.8	7.8	8.3	8.5	**8.2**	7.8	8.6	9.1	8.8	**8.8**	8.5
13	8.0	8.1	8.4	8.6	**8.4**	8.0	9.0	9.5	9.3	**9.3**	8.9
15	8.4	8.5	8.6	8.8	**8.6**	8.4	9.4	10.2	9.5	**9.7**	9.2
Av.Treatments	6.9	**7.1**	**7.6**	7.8	**7.5**	6.9	**7.6**	**8.1**	**7.5**	**7.7**	7.6
verage Ligh1800	**7.4**										
3500 Lux											
5	4.1	4.6	5.3	4.8	4.9	4.1	4	4.1	3.9	**4.0**	4.5
7	6.4	6.6	7.5	6.2	6.8	6.4	6.2	6.5	5.3	**6.0**	6.4
9	7.6	7.9	8.9	7.4	8.1	7.6	7.1	7.9	6.8	**7.3**	7.7
11	7.9	8.5	9.1	8.1	**8.6**	7.9	8.3	8.6	8.2	**8.4**	8.5
13	8.1	8.8	9.5	8.5	**8.9**	8.1	8.5	8.9	8.8	**8.7**	8.8
15	8.3	9.4	9.7	9.1	**9.4**	8.3	8.9	9.5	9.2	**9.2**	9.3
Av.Treatments	7.1	**7.6**	**8.3**	**7.4**	**7.8**	7.1	**7.2**	**7.6**	**7.0**	7.3	7.6
Average Light3500	**7.4**										
Combined Data											Av. Age
5	3.9	4.5	5.1	4.7	4.7	3.9	4.0	4.1	4.1	4.0	4.4
7	6.0	6.2	6.9	6.7	6.6	6.0	6.1	6.5	5.9	6.2	6.4
9	7.0	7.4	8.0	7.7	7.7	7.0	7.4	7.9	7.1	7.5	7.6
11	7.5	7.9	8.3	8.2	8.2	7.5	8.2	8.7	8.3	8.4	8.3
13	7.7	8.1	8.6	8.5	8.4	7.7	8.5	9.1	8.7	8.8	8.6
15	7.9	8.5	8.8	8.9	8.7	7.9	8.9	9.6	9.1	9.2	9.0
Av.Treatments	6.7	7.1	7.6	7.5	7.4	6.7	7.2	7.7	7.2	7.4	7.4

$LSD_{5\%}$ Light =0.1 **$LSD_{5\%}$ Light X Treat X Age = 0.1**
$LSD_{5\%}$ Treatment =0.2 **$LSD_{5\%}$ Treatment X Light =0.3**
$LSD_{5\%}$ Age =0.7 **$LSD_{5\%}$ Age X Treatment =0.2**
$LSD_{5\%}$ Concentration =0.09 **$LSD_{5\%}$ Treat. X Light X Conc. =0.6**

Generally, in both species, the most effective foliar GA_3 concentration treatment for inducing high number of first order branches plants was 750 ppm. The relationships between NAA concentrations and the resultant number of first order branches were different than in case of GA_3. Wherein, as the NAA concentration got higher the less branched plants were obtained. Therefore, the lower NAA concentration 200 ppm, seemed to be more

efficient in inducing more branched plants. Consequently, relative to the control, the average increased percentages in number of first order branches of *G.paniculata* plants due to NAA treatments 200, 400 and 600 ppm were; 111.1, 83.3 and 72.2%, respectively. The corresponding amounts due to same NAA concentrations in *G.elegans* were; 7.4, 14.9 and 7.4%, ranked in the same order.

Since analysis of variance proved significant interaction effects between all studied treatments, it could be concluded that the best stimuli combination to get more branched plants in *G.paniculata* was within the plants treated by 250 ppm GA_3, grown under 3500 Lux light intensity and harvested at the age of 19-21 weeks. *G.elegans* plants, treated by 500 ppm GA_3, grown under 3500 Lux light intensity and harvested at the age of 15-17 weeks from transplanted exhibited the highest number of first order branches. It is evident that, the used three light intensity and / or NAA treatments relatively do not affect the mean number of first order branches with appreciably great extent.The obtained results were supported by the findings reported by Hwang *et al.*, (2003). On the contrary Brian *et al.*, (1959) stated that, GA_3 treatments may suppress growth of lateral branches and this associated with stimulation s of stem growth.

3- Average number of inflorescences/plant

Tables (5&6) represent the average number of inflorescences per plant of *Gypsophila* plants as affected by foliar applications of four concentrations of GA_3 and NAA and grown under three different levels of light intensities. It is obvious that, all studied treatments significantly affected the averages of such trait and the interactions between the studied treatments were also significant. Therefore, *G.paniculata* plants exposed to 3500 Lux showed high number of inflorescences per plant as compared with those exposed to the other two levels of light intensities. While, in *G.elegans*, 1800 Lux was the effective treatments than the other levels. Percentages in number of inflorescences per plant due to the highest level of light intensity as compared with the lower one were 38.4 and 2.3% for *G.paniculata* and *G.elegans*, respectively.

The interactions between the used growth regulators and levels of light intensities significantly affected the mean number of inflorescences per plant. Plants of *G.paniculata*, treated with GA_3 and exposed to 3500 Lux illustrated more number of inflorescences per plant as compared with the other two used light intensities. Therefore, the average numbers of inflorescence per plant for such treatments were; 3672.8, 4151.4 and 5136.3 inflorescences per plant for GA_3 treatments with the other used light intensity in descending order. Even so, plants treated with NAA showed another trend. Wherein, the mean of such trait was 86.4 inflorescences per plant for plants treated with NAA and exposed to 1050 Lux compared with the other two light intensities 1800 and 3500 Lux. The other species; *G.elegans* showed another response towards the interactions between light intensities and growth regulator treatments. Since, plants exposed to 3500 Lux and treated with GA_3 showed more number of inflorescences per plant as compared with the other two light intensities. Similarly, plants treated with NAA and exposed to 1800 Lux.

Regarding the used concentrations effects, it is evident that, the untreated plants of *G.paniculata* do not produce inflorescences or achieved blooming. So, all used GA_3 and/or NAA concentrations caused an increase in number of inflorescences per plant with different degrees. For that reason, relative to the control, the average number, of inflorescences per plant in *G.paniculata* plants due to GA_3 concentrations 250, 500 and 750 ppm, were; 4005.7, 4345.6 and 4609.2, respectively. The corresponding amounts due to same GA_3 concentrations in *G.elegans* were; 12.2, 31.9 and 20.3% in the same order. Thus, GA_3 treatments are more efficient for inducing high number of inflorescences per plant in *G. paniculata*. Contrary, GA_3 treatments may show relatively low effects as a tool for inducing high number of inflorescences per plant in *G.elegans*. Generally, in *G.elegans*, the most effective foliar concentrations for inducing high number of inflorescences per plant were 500 ppm GA_3 and 400 ppm NAA. Accordingly, relative to the control, the average increased percentages in number of inflorescences per plant of *G.paniculata* plants owing to NAA treatments 200, 400 and 600 ppm were; 81.8, 74.1 and 68.1%, respectively. The corresponding amounts due to same NAA concentrations in *G.elegans* were; 1.2, 9.9 and 7.5% in the same order.

Table (5): Average number of inflorescences / plant of *G. paniculata* as affected by GA_3 and NAA under different levels of light intensities. (Pooled data of two successive winter seasons 2002/2003 and 2003/2004).

Light Intensity	1050 Lux										
Growth Reg.	GA3					NAA					
Concentrations Age(weeks)	0	250	500	750	Av. GA3XL.	0	200	400	600	Av. NAAXL	Av.TreatXL
19	0	2871.6	3776.8	3932.9	**3527.1**	0	80.5	75.8	70.0	**75.4**	1801.3
20	0	2902.8	4120.1	4057.7	**3693.5**	0	100.3	87.5	84.0	**90.6**	1892.1
21	0	2965.3	4182.6	4245.0	**3797.6**	0	102.6	89.8	87.5	**93.3**	1945.5
Av.Treatments	**0**	**2913.2**	**4026.5**	**4078.5**	**3672.8**	**0**	**94.5**	**84.4**	**80.5**	**86.4**	1879.6
AverageLight1050	**1409.7**										
1800 Lux											
19	0	3183.7	3714.4	4650.8	**3849.6**	0	64.1	61.8	57.1	**61.0**	1955.3
20	0	3495.9	3932.9	5243.8	**4224.2**	0	75.8	70.0	61.8	**69.2**	2146.7
21	0	3620.7	4120.1	5399.9	**4380.2**	0	88.6	80.5	72.3	**80.5**	2230.4
Av.Treatments	**0**	**3433.4**	**3922.5**	**5098.2**	**4151.4**	**0**	**76.2**	**70.8**	**63.7**	**70.2**	2110.8
AverageLight1800	**1583.1**										
3500 Lux											
19	0	4838.0	4744.4	4432.3	**4671.6**	0	68.8	57.1	54.8	**60.2**	2365.9
20	0	5899.3	5150.2	4713.2	**5254.2**	0	72.3	67.6	58.3	**66.1**	2660.2
21	0	6273.9	5368.7	4806.8	**5483.1**	0	82.8	77.0	67.6	**75.8**	2779.5
Av.Treatments	**0**	**5670.4**	**5087.8**	**4650.8**	**5136.3**	**0**	**74.6**	**67.2**	**60.2**	**67.4**	2601.9
AverageLight3500	**1951.4**										
Average Traetments X Conc. X Light											Av. Age
19	0	3631.1	4078.5	4338.7	4016.1	0	71.1	64.9	60.6	65.5	2040.8
20	0	4099.3	4401.1	4671.6	4390.6	0	82.8	75.0	68.0	75.3	2233.0
21	0	4286.6	4557.1	4817.2	4553.6	0	91.3	82.4	75.8	83.2	2318.5
Av.Treatments	**0**	4005.7	4345.6	4609.2	4320.2	**0**	81.8	74.1	68.1	74.7	2197.4

$LSD_{5\%}$ Light =22.8
$LSD_{5\%}$ Treatment =193.1
$LSD_{5\%}$ Age =46.8
$LSD_{5\%}$ Concentration =18.8
$LSD_{5\%}$ Light X Treat X Age =9.1
$LSD_{5\%}$ Treatment X Light =6.2
$LSD_{5\%}$ Age X Treatment =8.7
$LSD_{5\%}$ Treat. X Light X Conc. =4.8

From the abovementioned results the most favorable stimuli combinations to produce high number of inflorescences per plant in *G.paniculata* were among the plants treated by 250 ppm GA_3, grown under 3500 Lux light intensity, and harvested at the age of 20-21 weeks. In case of *G.elegans*, the three light intensities used with NAA treatments relatively do not affect the number of inflorescences per plant with noticeably great degree. Generally, plants treated with 500 ppm GA_3, grown under 3500 Lux light intensity and harvested at the age of 15 weeks from transplanted exhibited the highest number of inflorescences per plant. from the 17th week and occupied 4-5 weeks. The other species, *G.elegans* showed the same stages otherwise, it started to bloom normally earlier than the other species *G.paniculata* by about 2-4 weeks.

Table (6): Average number of inflorescences / plant of *G.elegans* as affected by GA_3 and NAA under different levels of light intensities.(Pooled data of two successive winter seasons 2002/2003 and 2003/2004).

Light Intensity	1050 Lux										
Growth Reg.	GA3					NAA					
Concentrations / Age (weeks)	0	250	500	750	Av. GA3XL.	0	200	400	600	Av. NAAXL	Av.TreatXL
13	250.8	254.4	334.8	285.6	**291.6**	250.8	250.8	273.6	265.2	**263.2**	277.4
14	271.2	300	360	324	**328.0**	271.2	274.8	297.6	292.8	**288.4**	308.2
15	278.4	334.8	416.4	370.8	**374.0**	278.4	285.6	303.6	300	**296.4**	335.2
Av.Treatments	**266.8**	**296.4**	**370.4**	**326.8**	**331.2**	266.8	**270.4**	**291.6**	**286.0**	**282.7**	307.0
AverageLight1050											**296.9**
1800 Lux											
13	261.6	274.8	363.6	314.4	**317.6**	261.6	267.6	303.6	292.8	**288.0**	302.8
14	278.4	314.4	430.8	381.6	**375.6**	278.4	292.8	327.6	314.4	**311.6**	343.6
15	289.2	360	462	409.2	**410.4**	289.2	324	352.8	342	**339.6**	375.0
Av.Treatments	**276.4**	**316.4**	**418.8**	**368.4**	**367.9**	**276.4**	**294.8**	**328.0**	**316.4**	**313.1**	340.5
AverageLight1800											**324.5**
3500 Lux											
13	267.6	303.6	292.8	288	**294.8**	267.6	261.6	278.4	267.6	**269.2**	282.0
14	292.8	327.6	314.4	312	**318.0**	292.8	278.4	300	307.2	**295.2**	306.6
15	324	352.8	342	339.6	**344.8**	324	310.8	327.6	321.6	**320.0**	332.4
Av.Treatments	**294.8**	**328.0**	**316.4**	**313.2**	**319.2**	**294.8**	**283.6**	**302.0**	**298.8**	**294.8**	307.0
AverageLight3500											**304.0**
Combined Data											Av. Age
13	260.0	277.6	330.4	296.0	301.3	260.0	260.0	285.2	275.2	273.5	287.4
14	280.8	314.0	368.4	339.2	340.5	280.8	282.0	308.4	304.8	298.4	319.5
15	297.2	349.2	406.8	373.2	376.4	297.2	306.8	328.0	321.2	318.7	347.5
Av.Treatments	279.3	313.6	368.5	336.1	339.4	279.3	282.9	307.2	300.4	296.9	318.2

$LSD_{5\%}$ Light =7.2
$LSD_{5\%}$ Treatment =9.8
$LSD_{5\%}$ Age =5.1
$LSD_{5\%}$ Concentration =11.1

$LSD_{5\%}$ Light X Treat X Age =6.7
$LSD_{5\%}$ Treatment X Light =4.1
$LSD_{5\%}$ Age X Treatment =2.1
$LSD_{5\%}$ Treat. X Light X Conc. =3.4

Generally, in both species, all treated plants showed significant differences in concern with number of days elapsed to flowering. Therefore, the effects of the four studied treatments; light intensities, growth regulators, types and concentrations as well as plant age will be forward discuss.

Data offered in Table (7& 8) represent that, in both species, the highest level to light intensity 3500 Lux significantly enhanced plants toward flowering as compared with the other two light intensities 1800 and 1050 Lux. So, negative significant relationships could be recognized between days elapsed to flowering and the used light intensity. As the light intensity increased the days elapsed to flowering decreased. So, plants of *G.paniculata*, which subjected to the highest light intensity, exhibited full blooming 20 and 35.5 days earlier than those subjected to 1800 and 1050 Lux, respectively. However, plants of *G.elegans*, which subjected to the same light intensities, substantiated full blooming 16 and 31 days earlier than those subjected to 1800 and 1050 Lux, respectively.

Data pertaining effects of growth regulators on number of days elapsed to flowering proved that, the untreated *G.paniculata* plants, do not produce flowers. Indicating that, growth regulators treatments were essential for *G.paniculata* plant to produce flowers. On the other hand, the untreated plants of *G.elegans* showed normal flowering behavior with all used treatments, indicating that these plants of such species do not need further treatments of growth regulators for flower production. This meant that using GA_3 and NAA treatments accelerated flowering not on flower production. It was realized that, in both species, GA_3 treatments were more effective for flower production.

So, the average number of days elapsed to flowering was reduced significantly by GA_3 treatments comparing with NAA treatments. Therefore, in *G.paniculata* the means of such trait for GA_3 and NAA treatments under the highest light intensity 3500 Lux were 97 and 107 days (DAT), respectively. The same trend was obtained in case of *G.elegans* with relatively low magnitude. Hence the corresponding numbers were 87 and 104 days for the same treatment in the same order.

Data presented in Tables (7&8) illustrated that, in both species the lowest GA_3 concentration 250 ppm significantly enhanced plants toward flowering as compared with the other used two concentrations 500 and 750 ppm. So, positive significant relationships could be established between days elapsed to flowering and the GA_3 concentrations used. Since, the used concentrations increased the days to flowering increased too. Therefore, plants of *G.paniculata*, which subjected to the lowest GA_3 concentration, exhibited full blooming 14 to 25 days earlier than the other two concentrations, respectively. However, plants of *G.elegans*, which subjected to the same GA_3 concentration, substantiated full blooming 12 to 22 days earlier than those subjected to the other two GA_3 concentrations. Regarding the effects of NAA concentrations, in case of *G.paniculata*, the average number of days elapsed to flowering was 18 days for plants exposed to 200 ppm earlier than those at 400 ppm and 33 days at 600 ppm. In case of *G.elegans* plants exposed to 200 ppm was 16 days earlier than those at 400 ppm and 20 days than those at 600 ppm.

The interaction between these three treatments were significant, indicating that each factor alone or combined with the other treatments affecting the mean average of days elapsed from transplanting to flowering.

Table (7): The average number of days from transplanting to flowering of *G.paniculata as* affected by GA_3 and NAA under different levels of light intensities. (Pooled data of two successive winter seasons 2002/2003 and 2003/2004).

Light Intensity	1050 Lux										
Growth Reg.	GA3					NAA					
Concentrations Age (weeks)	0	250	500	750	Av. GA3XL.	0	200	400	600	Av. NAAXL	Av.TreatXL
First wave	0	110	124	133	122	0	131	151	171	151	137
Second wave	0	122	138	147	136	0	145	165	185	165	151
Av.Treatments	0	116	131	140	129	0	138	158	178	158	144
AverageLight1050	143.5										
1800 Lux											
First wave	0	96	114	131	114	0	116	138	149	134	124
Second wave	0	98	126	141	122	0	122	146	157	142	132
Av.Treatments	0	98	120	136	118	0	119	142	153	138	128
AverageLight1800	128										
3500 Lux											
First wave	0	88	93	97	93	0	105	114	127	105	99
Second wave	0	94	99	111	101	0	109	122	137	109	105
Av.Treatments	0	91	96	104	97	0	107	118	132	107	102
AverageLight3500	108										
Combined Data											Av. waves
First count	0	98	110	120	110	0	117	134	149	130	120
Second count	0	105	121	133	120	0	125	144	160	139	129
Av.Treatments	0	102	116	127	115	0	121	139	154	134	125

$LSD_{5\%}$ Light =2.6 — $LSD_{5\%}$ Light X Treat X wave =1.1
$LSD_{5\%}$ Treatment =1.2 — $LSD_{5\%}$ Treatment X Light =1.1
$LSD_{5\%}$ Concentration =2.3 — $LSD_{5\%}$ Treat. X Light X Conc. =1.7

Table (8): The average number of days from transplanting to flowering of *G.elegans as* affected by GA_3 and NAA under different levels of light intensities. (Pooled data of two successive winter seasons 2002/2003 and 2003/2004).

Light Intensity	1050 Lux										
Growth Reg.	GA3					NAA					
Concentrations Age (weeks)	0	250	500	750	Av. GA3XL.	0	200	400	600	Av. NAAXL	Av.TreatXL
First wave	127	99	112	120	110	127	118	136	144	133	122
Second wave	133	110	124	132	122	133	131	149	157	146	134
Av.Treatments	130	104	118	126	116	130	124	142	150	139	128
AverageLight1050	128										
1800 Lux											
First wave	108	86	103	118	103	108	104	124	124	117	110
Second wave	112	88	113	127	110	112	110	131	131	124	117
Av.Treatments	110	88	108	122	106	110	107	128	128	121	114
AverageLight1800	113										
3500 Lux											
First wave	98	79	84	87	84	98	95	103	104	101	93
Second wave	108	85	89	100	91	108	98	110	113	107	99
Av.Treatments	103	82	86	94	87	103	96	106	109	104	96
AverageLight3500	97										
Combined Data											Av. waves
First count	111	88	99	108	99	111	105	121	124	117	108
Second count	118	95	109	120	108	118	113	130	134	126	117
Av.Treatments	114	92	104	114	104	114	109	125	129	121	113

$LSD_{5\%}$ Light = 4.1 — $LSD_{5\%}$ Light X Treat X wave = 3.2
$LSD_{5\%}$ Treatment = 2.7 — $LSD_{5\%}$ Treatment X Light =1.9
$LSD_{5\%}$ Concentration = 1.3 — $LSD_{5\%}$ Treat. X Light X Conc. =1.2

The results of the present study dealing with effects of different levels of light intensities and GA_3 on flowering capacity and date are strongly supported by the findings reported earlier by Yu, *et al.,* (2000). The changes in plant morphology and physiology indicate a phase of change or transition to floral determined stage. Mechanism by which plant hormones can perform this function remains unclear.

Regarding the effect of NAA it is evident that, the uses of synthetic auxins can be traced directly to the roles of IAA in plant. So, NAA compounds are used because they resemble IAA in action but are resistant to degradation by plant enzymes. On the main time, as far as the authors were aware no detailed study dealing with NAA effects on *Gypsophila* plant was found.

This study outcome results dealt with the effects of the studied treatments; light intensities; (1050, 1800 and 3500 Lux), growth regulators (GA_3 and NAA), concentrations (four doses each) and plant species, *G.paniculata* and *G.elegans* on the morphological and reproductive characters must be discussed on the view that *Gypsophila* plants considered long-day plants and characterized by weak apical dominance. Therefore, when the plant is stimulated by long-days, the stem elongates and terminates in blooming. Under short-day conditions and low temperatures the plant's development terminates in a rosette of leaves. According to its growth pattern, *Gypsophila* is defined as an obligatory and quantitative long –day plant. This means that long–day conditions will enable the plant to proceed from the vegetative stage to the flowering stage. So, it could be concluded that day length, temperature and light intensity affect plant growth stages and are crucial at the stages of bolting and flower induction (initiation and formation of flowering buds). For that reason flowering will not occur unless one of the environmental treatments (day length, temperature, light intensity) is changed (Anon 1997).

The two studied *Gypsophila* species; *G.paniculata* and *G.elegans* showed a distinctive growth patterns, assuming that *G.elegans* plants likely to be as a neutral day plant, since the untreated plants mainly characterized by moderate vegetative growth and slightly goes toward blooming. This supported the fact that *G.elegans* plants are native to the Egyptian conditions and found in Sinai region Täckholm, (1974). On the contrary, *G.paniculata* plants were obligatory long–day plants, since it showed relatively poor vegetative growth and do not goes toward blooming under the Egyptian biosphere conditions.

Lighting is a very important factor in *G.paniculata*. For that reason artificial lighting during growth is regularly used. The effect of different light intensities usually shorten the growth process and artificial lighting with suitable intensity is important with some cautions because the early artificial lighting will promote poor growth quality with low flowering yield. Ruth and Abraham (1982) reported that long-day promotes flowering of *G. paniculata* L. cv. 'Bristol Fairy'. They concluded that, repeated treatments with GA_3 in short-days do not promote flowering. Moreover, long photoperiod is effective only at relatively high temperatures. While, high light intensity during the day

has a decisive effect on flower production. It is also reported that, flowering date was directly related to the logarithm of the total light influence between 1 and 100 mMol m−2 night−1. The most economical application was to illuminate the plants throughout the night by moderate light intensity Avishag and Meir (1989). The other factor needs further studies is the vernalization effects. Wherein, Amezquita *et al.*, (1999) reported that, the reproductive and vegetative growth of *G.paniculata* was interpreted using photoperiod and vernalization. All the plants used had reached the same physiological age; flower inducement was more effective after 45 days of vernalization and 16 hr /day of light over 70 days. The present investigation indicated that the two studied *Gypsophila* species showed different responses regarding to flower inducement.

Growth regulators are organic substances which influence at low concentrations plant physiological processes; growth, differentiation and development. Gibberellins mainly caused hyper elongation of stems by stimulating both cell division and cell elongation. It is also used for bolting in long day plants as well enhancement of flower bud formation. The two used growth regulators were, GA_3 and NAA with four different concentrations. It is obvious clearly from this investigation that, GA_3 treatments generally, seemed to be more suitable to gain suitable vegetative and reproductive traits especially with *G.paniculata*. NAA treatments proved to be less effective tool for enhancing vegetative and reproductive characters in both species as compared with GA_3 treatments.

These results supported by Millar (1962) who stated that gibberellin may cause elongation by the induction of enzymes that weaken the cell walls. It is also noticed that gibberellins may also transport auxins to the action site of action in plants. Davies *et al.*, (1996) studied growth regulator effects on flowering of *G. paniculata* L. cvs Bristol Fairy and Bridal Veil. They reported that, both cultivars bolted and formed flower buds very rapidly in long day (LD) without growth regulators treatments (WN) irrespective of pretreatment, but both final stem height and yield were low. On the other hand, GA_3 or BA promoted flowering and improved yield in all plants grown in long day conditions. Flower quality was diminished by in case of zero growth regulators treatments particularly under unvernlized conditions, due to a loss of apical dominance and branch weakness. BA application also resulted in poor flower quality due to the matting of fine branch lets in the inflorescences.On the same time, Karaguzel (1996) stated that, GA_3 significantly increased plant height, number of flowering shoots/plant and the length of flowering shoots at harvest. As the number of GA_3 applications increased, the fresh weights of flowering shoots at harvest decreased. However, the total fresh weight of cut flowers/plant increased with GA_3 treatments. Unlike, the promoting effects occurred on morphological and flowering traits due GA_3 treatments. NAA treatments proved to be not as much of expected to increase the mean values of such traits.

Generally, the interactions between light intensity, day length and GA3 were investigated earlier by many workers as they reported that, when plants of *Hyoscymus niger* were treated with gibberellin, stem elongation is

reported to occur Lang, (1956a) and the plants were induced to produced flowers Lang, (1956b,c). In later studies, it has been proved that different gibberellins have different effect on plants Michniewiez and Lang, (1962). However, it was reported that application of GA_3 to *Poa pratensis* was sufficient to replace induction by long day treatment Heide *et al.*, (1998).

Anatomical study

a- The root

Readings of microscopic measurements as shown in root transverse sections of *Gypsophila* plants treated by different concentrations of GA_3 and NAA and grown under the highest light intensity of 3500 Lux are presented in Table (9) and Figures (1 & 2). It is obvious that, the two *Gypsophila* species showed the same general anatomical features. However, *G.elegans* always produced the highest measurements of certain anatomical characters as compared with the other *G.paniculata*. These measurements include, average root diameter, periderm thickness, vascular cylinder diameter, thickness of both secondary phloem and xylem as well as average diameter of vessel.

Regarding the effects of foliar application of GA_3, relative with the control, GA_3 treatments caused prominent increments in root diameter with different extents according to the used GA_3 concentration. This increase reached 9.0% as an average in roots of plants adapted to GA_3 treatments. The average increased percentage in periderm thickness due to GA_3 treatments was 35.5% as compared with the control. Nevertheless, the average diameter of the vascular cylinder of GA_3 treated plants was relatively thinner 2150.7 µ as compared with those of control plants 2229.3 µ. This reduction in the diameter of the vascular cylinder due to GA_3 treatment may be owing to the reduction occurred in the thickness of secondary xylem that showed 4.8% reduction in thickness as an average when compared with its relative control. Meanwhile, another prominent reduction observed in the average xylem vessel diameter.

Generally it could be concluded that GA_3 treatments caused an increase in root diameter as a result of increased thickness of periderm tissue only not to increases that may occurred in other tissues shared in its structure. While, These increments in root diameter associated with an appreciable reduction in the diameter of root vascular cylinder including thinner secondary xylem vessels.

NAA treatments showed another trend of effects as shown in Table (9) and Figures (1&2). Where, relative to the control, plants adapted to NAA application showed thicker root diameter. These thick roots showed an appreciable increase in measurements of all tissues shared in root internal structure. Where, the increments percentages resulted from NAA treatment relative to the control were, 16.2, 43.2, 3.0 and 8.31% for the average root diameter, thickness of periderm, vascular cylinder diameter and thickness of secondary xylem, respectively. It is worthy to mention that, in both *Gypsophila* species, average vessel diameter showed a remarkable decrease as a result of GA3 treatments. While, NAA treatments produced an increasing in the average thickness of vessel diameter. Same trend of results were obtained with *G.elegans* in response to the same adopted GA_3 and/or NAA

treatments. As far as the authors were aware no detailed study dealing with GA3 or NAA effects on internal structure of *Gypsophila* plant was carried out.

Table (9): **Measurements of certain anatomical characters of root transverse sections of *G.paniculata* and *G.elegans* treated with four different concentrations of GA_3 and NAA grown under 3500 lux light intensity.**

easurem-ents (μ)	Cont-rol	GA_3 250 ppm	GA_3 500 ppm	GA_3 750 ppm	Mean GA_3	% ± Contr ol	NAA 200 ppm	NAA 400 ppm	NAA 600 ppm	Mean NAA	% ± Control
Gypsophila paniculata L.											
Ave. root diameter	2856.3	3230.2	3147.3	2966.1	3114.5	+ 9.0	3538.1	3383.1	3041.2	3320.8	+ 16.2
Ave. periderm thickness	337.5	505.5	466.2	4013	457.6	+ 35.5	598.7	463.7	388.4	483.6	+ 43.2
Ave. Vascular cylinder diameter	2229.3	20975	2147.3	2207.3	2150.7	- 3.5	2312.7	2300.0	2280.1	2297.6	+ 3.0
Sec. phloem thickness	120.2	157.1	141.8	135.7	144.8	+ 20.4	172.2	157.3	144.8	158.1	+ 31.5
Sec. xylem thickness	912.0	844.8	863.7	894.2	867.5	- 4.8	1015.3	986.2	963.1	988.2	+ 8.3
Ave. vessel diameter	69.8	61.9	63.5	65.4	63.6	- 8.8	74.2	72.9	71.2	72.7	+ 4.1
Gypsophila elegans											
Ave. root diameter	3370.4	3841.6	3763.8	3550	3718.4	+ 10.0	4775	3992.1	3588.6	4118.5	+ 22.1
Ave. periderm thickness	398.3	599.5	570.1	499.5	556.3	+ 39.6	716.5	567.2	458.3	580.6	+ 45.7
Ave. Vascular cylinder diameter	2630.6	2604.6	2503.8	2465.1	2524.5	- 4.0	2819	2780.0	2690.5	2763.1	+ 5.0
Sec. phloem thickness	141.8	185.4	177.3	160.1	174.2	+ 22.8	203.2	195.6	170.9	189.9	+ 33.9
Sec. xylem thickness	1076.2	1055.2	1010.2	986.9	1017.4	- 5.4	1198.1	1173.7	1156.5	1176.1	+ 9.2
Ave. vessel diameter	82.4	78.2	75.9	78.2	75.7	- 8.1	88.6	86.0	84.0	86.2	+ 4.6

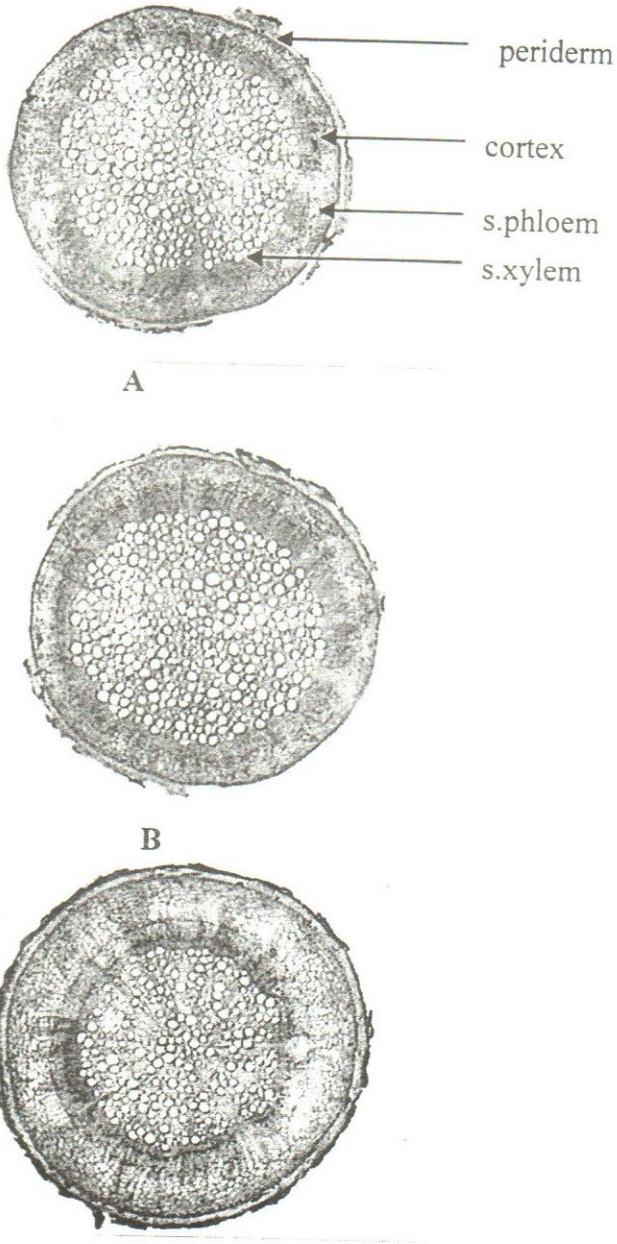

Figure (1): Transverse section in the fibrous root of *G.paniculata* plant grown under 3500 Lux light intensity.
A- Control B- Plant treated with GA_3 (250 ppm)
C- Plant treated with NAA (200 ppm) (X 40)

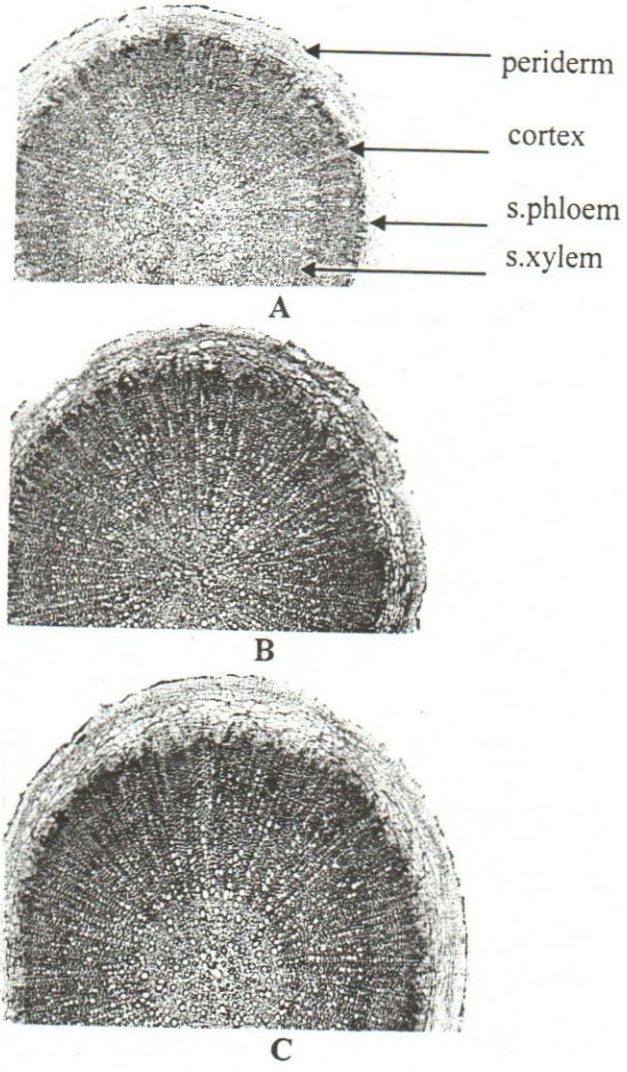

Figure (2): Transverse section in the fibrous root of *G.elegans* plant grown under 3500 Lux light intensity.
A- Control B- Plant treated with GA_3 (250 ppm)
C- Plant treated with NAA (200 ppm) (x40)

b- The stem

Data contributing to the effects of different concentrations of GA_3 and NAA on anatomical stem structure of the two studied *Gypsophila* species are presented in Table (10) and Figures (3&4). Microscopical measurements and counts of stem transverse sections illustrated that, relative to the control, foliar application of GA_3 induced an inconsequential decrease in whole stem diameter by -5.8 and -6.6 % for *G.paniculata* and *G.elegans* respectively. These reductions in stem diameter were achieved as the used foliar GA_3 concentrations increased.

Table (10): Measurements of certain anatomical characters of stem transverse sections of *G.paniculata* and *G.elegans* treated with four different concentrations of GA_3 and NAA. Under 3500 Lux light intensity.

Measurements (µ)	Control	GA_3 250 ppm	GA_3 500 ppm	GA_3 750 ppm	Average GA_3	%± Control	NAA 200 ppm	NAA 400 ppm	NAA 600 Ppm	Average NAA	ntrol
Gypsophila paniculata											
Stem diameter	4009	3936	3781	3611	3776.0	-5.8	4925	4762	4625	4770.7	+19.0
Epidermis thick.	28.3	28.9	29.0	29.2	29.0	+2.6	28.8	28.8	28.6	28.7	+1.5
Cortex thick.	321.6	387.2	425.3	440.3	417.6	+29.9	415	349.1	335.2	366.4	+13.9
Fiber sheath thick.	69.2	111.7	129.3	135.7	125.6	+81.5	109.2	102.4	71.4	94.3	+36.3
Vascular cylinder thick.	137.2	131.7	127.7	122.9	127.4	-7.1	166.8	154.2	154.3	158.4	+15.5
Sec. phleom thick	52.4	44.9	35.5	33.7	38.0	-27.4	77.3	67.1	56.8	67.1	+28.0
Sec. xylem thick	76.4	86.0	91.9	98.6	92.2	+20.6	92.4	88.3	82.2	87.6	+14.7
Vessel diameter	32.5	30.8	31.5	31.9	31.4	-3.3	31.9	31.0	30.2	31.0	-4.6
Pith diameter	2964	2724	2546	2441	2570.3	-13.3	3401	3254	3114	3256.3	+.9.8
Gypsophila elegans											
Stem diameter	4650.4	4565.8	4289.2	4170.8	4341.9	-6.6	5690	5523.9	5488	5567.3	+19.7
Epidermis thick.	32.8	32.8	33.2	33.9	33.3	+1.4	32.6	33.4	33.5	33.2	+1.0
Cortex thick.	373.1	440.2	470.6	510.7	473.8	+27.0	477.2	405.0	370.2	417.5	+11.9
Fiber sheath thick.	80.3	119.4	140.2	157.4	139.0	+73.2	121.6	118.8	92.5	111.0	+38.2
Vascular cylinder thick.	159.2	147.3	148.1	142.6	146.0	-8.3	200.1	178.9	175	184.7	+16.0
Sec. phloem thick	60.8	54.1	46.2	39.1	46.5	-23.6	86.3	71.2	55.9	71.1	+17.0
Sec. xylem thick	88.6	99.8	102.6	111.6	104.7	+18.1	105.6	102.4	92.5	100.2	+13.0
Vessel diameter	36.9	35.7	35.5	36.9	36.0	-2.4	36.2	36.0	34.2	35.5	-3.7
Pith diameter	3438.2	3159.8	2900.4	2810.7	2957.0	-14.0	5046.9	3774.6	3490.7	3770.4	+9.7

It is also noticed that, in both species, the reduction occurred in the stem diameter due to GA_3 treatments was linked with remarkable decrease in thickness of both vascular cylinder as well as pith diameter. Relative to the

control, the reduced percentages in thickness of vascular cylinder and pith diameter were -7.1 and -13.3% in *G.paniculata*, respectively. While the corresponding reduced percentages in case of *G.elegans* were -8.3 and -14.0% for the same studied traits, in the same order. Moreover, a reduction was observed in thickness of the vascular cylinder in all GA_3 treated plants.

On the contrary, a remarkable increase of 20.6 and 18.1% were noticed in thickness of secondary xylem. This increase in thickness of secondary xylem was accompanied by a severe reduction in thickness of secondary phloem where, -27.4 and -23.6% for *G.paniculata* and *G.elegans*, respectively. In addition, the average vessel diameter was also decreased due to GA_3 treatments. Where, vessel diameter was decreased by -3.3 and -2.4% for *G. paniculata* and *G. elegans*, respectively. It is also observed that, both cortex and stem fiber sheath in GA_3 treated plants showed a relatively increased thickness as compared with their respective control. These increments in thickness of cortex and fiber sheath were relatively small to compensate the reduction occurred in thickness of the vascular cylinder or that occurred in pith diameter of treated plants.

Transverse sections of stem of the two studied Gypsophila species as affected by different GA_3 and NAA concentrations are presented in Table (10) and Figures (3&4). It is observed that, in both species, all NAA treatments caused a steady increase in stem diameter. This increase was achieved by all adopted concentrations. The average percentages of stem diameter increments were 19.0 and 19.7% for the two studied species; *G. paniculata* and *G.elegans*, respectively. Generally, it is clear that NAA treatments resulted in a remarkable increase in measurements of all shared tissues in stem components; epidermis, cortex, stem fiber sheath, vascular cylinder (secondary phloem and secondary xylem) as well as pith diameter. The average increments percentages due to NAA treatments were, 1.0, 11.9, 38.2, 16.0, 17.0, 13.0 and 9.7 % for of the abovementioned certain anatomical measurements in the same order. On the contrary, NAA treatments produced narrow vessels. Since, average vessel diameter of NAA treated plants was reduced in all treated plants of both species compared with their respective control.

As far as the authors were aware no detailed study dealing with GA_3 or NAA effects on internal structure of *Gypsophila* plant was carried out. However, Metcalfe and Chalk, (1979) described stem structure of the plants belongs to *caryophyllaceae* and mentioned that, the epidermis including longitudinal rows of papillose cells. Cork usually arising in the outermost part of the cortex or sometimes has sub epidermal origin. Cortex had not exhibiting distinctive features, frequently narrow and sometimes containing assimilatory tissue; the inner part consisting of small cells with very thick mucilaginous walls. Vascular bundles had not individually distinct in transverse sections, but xylem and phloem forming continuous rings. Vessels with simple perforation mainly comprise the wood. Parenchyma frequently was constituting a large proportion of the wood. Rays generally absent. Pith is generally wide.

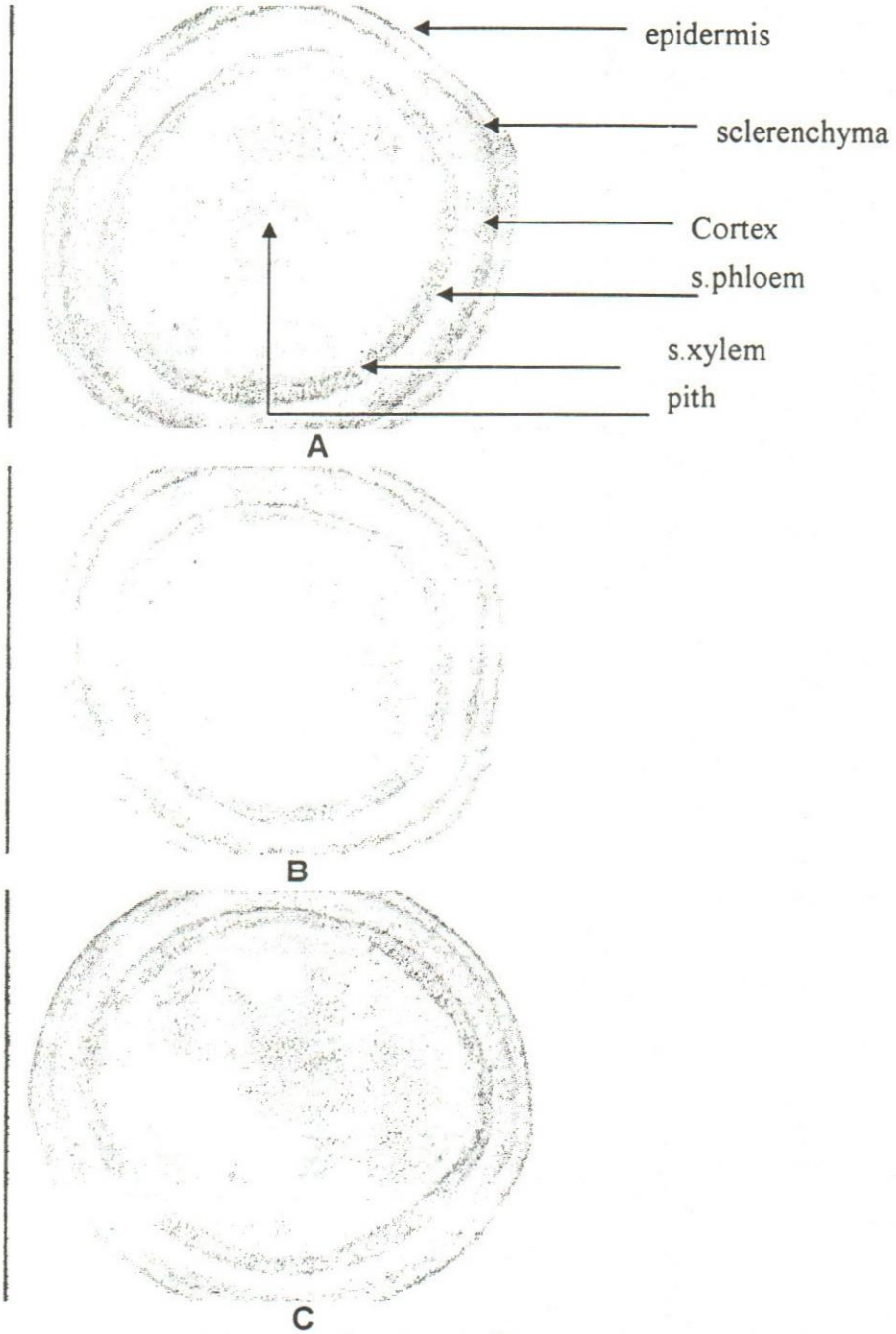

Figure (3): Transverse section in the 4th internode on the main stem of *G. paniculata* plant grown under 3500 lux light intensity. A- Control B- plant treated with GA_3 (250 ppm) C- plant treated with NAA (200 ppm) (X 40).

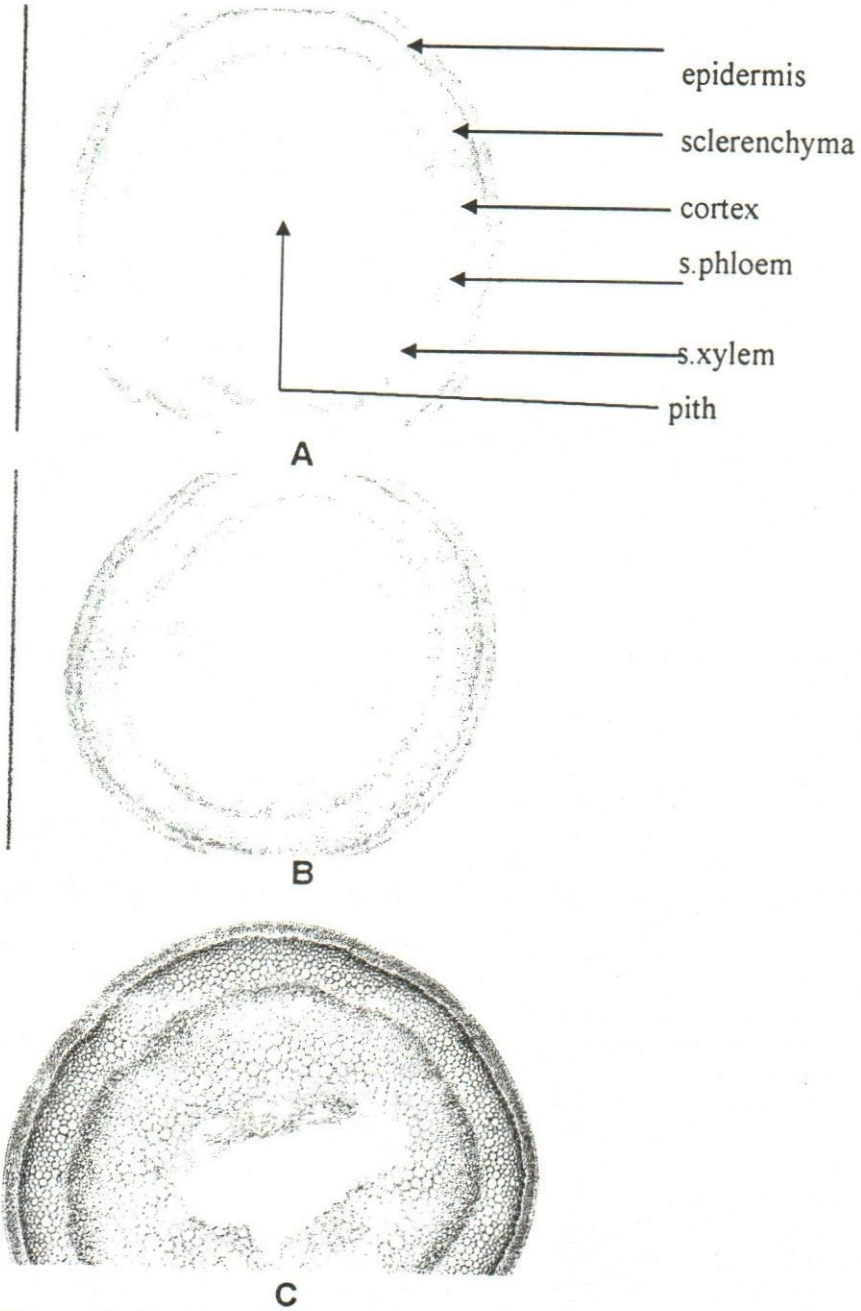

Figure (4): Transverse section in the 4th internode on the main stem of *G.elegans* plant grown under 3500 Lux. Light intensity.
A- Control B- plant treated with GA_3 (250 ppm)
C- plant treated with NAA (200 ppm) (X 40)

c- The leaf blade

Microscopic measurements as detected in leaf balde transverse sections of the two *Gypsophila* species treated by different levels of GA_3 and NAA are presented in Table (11) and Figures (5&6). It is obvious that, in both species, all measurements of certain anatomical characters of GA_3 treated plants showed a remarkable reduction as compared with their respective controls. As, means of the following anatomical features were appreciably decreased with remarkably different extents; thickness of leaf midrib, thickness of midvein bundle, average of vessel diameter, thickness of lamina, thickness of upper and lower epidermis, average thickness of upper and lower palisade layers, average thickness of spongy tissue as well as thickness of leaf mesophyll tissue.

So it could be stated that, the thickness of midrib bundle and average diameter of vessel of all GA_3 treated plants exhibited notable reduction due to GA3 treatments. Relative to the control, the reduction percentages were (10.3, -3.2 and -11.2, 3.3%) for midrib thickness and vessel diameter for *G.paniculata* and *G. elegans*, respectively. NAA treatments showed a reversible trend. As, all NAA treatments resulted in a prominent stable increase in average thickness of leaf midrib, average thickness of midrib bundle as well as the average vessel diameter. The increased percentages, in *G.paniculata*, were 10.1, 7.8 and 6.4% for average thickness of leaf midrib, average thickness of midrib bundle and average vessel diameter, respectively. The corresponding increased percentage for the same anatomical features in the same order were; 22.6, 19.5 and 16.7% in *G.elegans.*

It is observed that, in both species, all NAA treatments resulted in a prominent increase in thickness of lamina. This increase was achieved by all adopted concentrations. The average increased percentages of leaf lamina 10.3 and 22.5% for *G.paniculata* and *G.elegans*, respectively. Generally, in *G.paniculata*, it is clear that, NAA treatments resulted in a remarkable increase in measurements of all shared tissues in leaf lamina; upper and lower epidermis, upper and lower palisade layers, as well as spongy tissue. The average increments percentages due to NAA treatments were, 10.7, 12.0, 9.3, 10.8 and 8.9 % respectively. Same trend was obtained in case of *G.elegans*, wherein, the corresponding increased percentage due to NAA treatments were; 21.8, 22.0, 21.6, 22.4 and 20.5% for the same mentioned certain anatomical measurements in the same order.

Regarding the effects of foliar application of GA_3 on leaf lamina structure, relative with the control, GA_3 treatments resulted in stable notable reduction in lamina thickness with different extents depending on the adopted GA_3 concentration. This reduction reached to -10.0 and 10.2 % as an average in leaf lamina of *G.paniculata* and *G.elegans* plants adapted to GA_3 treatments respectively. This reduction in average lamina thickness mainly referred to the reduction occurred in both palisade and spongy tissue thickness, were all plants treated with GA_3 showed a remarkable thin palisade and spongy tissue compared to the control. The reduction average percentages of palisade thickness due to GA_3 foliar treatments, in *G.paniculata*, were -8.7 and -16.5% for upper and lower palisade layers as

compared with the control. However, the reduction average percentages of palisade thickness due to GA_3 foliar treatments, in *G.elegans* were -9.5 and -14.7% for the same mentioned layers as compared with their respective control. Moreover, another prominent reduction observed in the average thickness of spongy tissue. Generally it could be concluded that GA_3 treatments caused remarkable decrease in all tissues shared in lamina composition.

Table (11): Measurements of certain anatomical characters of leaf blade transverse sections of *G.paniculata* and *G.elegans* treated with four different concentrations of GA_3 and NAA under 3500 Lux light intensity.

Measurements (µ)	Control	GA_3 250 ppm	GA_3 500 ppm	GA_3 750 ppm	Avre-age GA_3	%± Con-rol	NAA 200 ppm	NAA 400 ppm	NAA 600 ppm	Aver-age NAA	%± Cont-rol
Gypsophila paniculata											
Thickness of mid rib	2958	2785.3	2620.4	2550	2651.9	-10.3	3101.1	3287.2	3380.2	3256.2	10.1
Thick. of mid rib bundle	724.6	700.1	627.3	589.7	639.0	-11.8	744.2	788.9	811.2	781.4	7.8
Vessel diameter	45.3	44.8	43.7	43	43.8	-3.2	45.9	48.7	50.0	48.2	6.4
Thickness of lamina	1910.6	1779.3	1721.6	1659.3	1720.1	-10.0	2006.3	2126.7	2186.9	2106.6	10.3
Thick. Of upper epidermis	25.7	25.2	23.1	22.1	23.5	-8.7	27.1	28.7	29.5	28.5	10.7
Thick. Of lower epidermis	19.5	18.8	19	19.8	19.2	-1.5	20.8	22.0	22.7	21.8	12.0
Thick. Of upper palisade	737.9	682.1	673.9	666	674.0	-8.7	768.2	814.3	837.3	806.6	9.3
Thick. Of lower palisade	347.1	302.1	291.3	275.8	289.7	-16.5	366.4	388.4	399.4	384.7	10.8
Thick. of spongy tissue	792.8	734.6	701.8	668.4	701.6	-11.5	822.2	871.5	896.2	863.3	8.9
Thick. of mesophyll tissue	1889.2	1725.6	1679.5	1618.4	1674.5	-11.4	1965.4	2083.3	2142.3	2063.7	9.2
Gypsophila elegans											
Thickness of mid rib	3165.1	2880.3	2803.8	2750.6	2811.6	-11.2	3690.3	3931.1	4022.4	3881.3	22.6
Thick. of mid rib bundle	775.3	731.5	671.2	621.4	674.7	-13.0	875.3	938.7	965.3	926.4	19.5
Vessel diameter	48.5	47.9	46.6	46.0	46.8	-3.3	53.2	57.9	58.6	56.6	16.7
Thickness of lamina	2044.3	1919.3	1810.5	1775.5	1835.1	-10.2	2366.2	2530.7	2615.7	2504.2	22.5
Thick. Of upper epidermis	27.5	27.0	25.7	23.6	25.4	-7.5	32.2	33.1	35.2	33.5	21.8
Thick. Of lower epidermis	20.9	20.1	19.3	20.2	19.9	-4.8	24.8	25.2	26.4	25.5	22.0
Thick. Of upper palisade	789.6	729.8	712.1	700.6	714.2	-9.5	920.4	969.0	989.7	959.7	21.6
Thick. Of lower palisade	371.4	343.2	311.7	295.1	316.7	-14.7	426.2	462.2	475.3	454.5	22.4
Thick. of spongy tissue	848.3	786.0	740.1	710.6	745.6	-12.1	978.4	1020.6	1066.5	1021.8	20.5
Thick. of mesophyll tissue	2040.3	1843.7	1813.9	1766.3	1808.0	-11.4	2338.8	2479.2	2600.1	2472.7	21.2

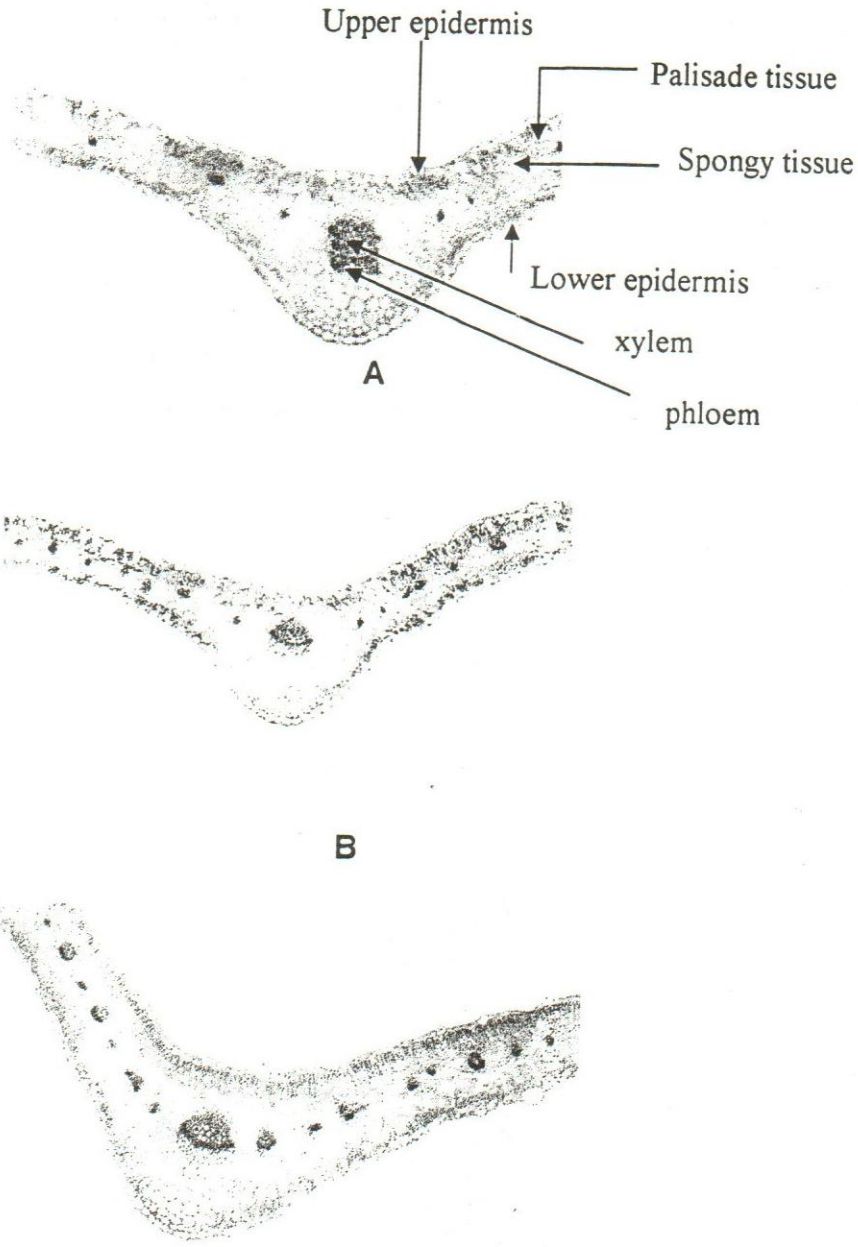

Figure (5): Transverse section in leaf blade of *G. paniculata* plant grown under 3500 lux light intensity
A- control B- plant treated with GA_3(250 ppm)
C - plant treated with NAA (200 ppm) (X40)

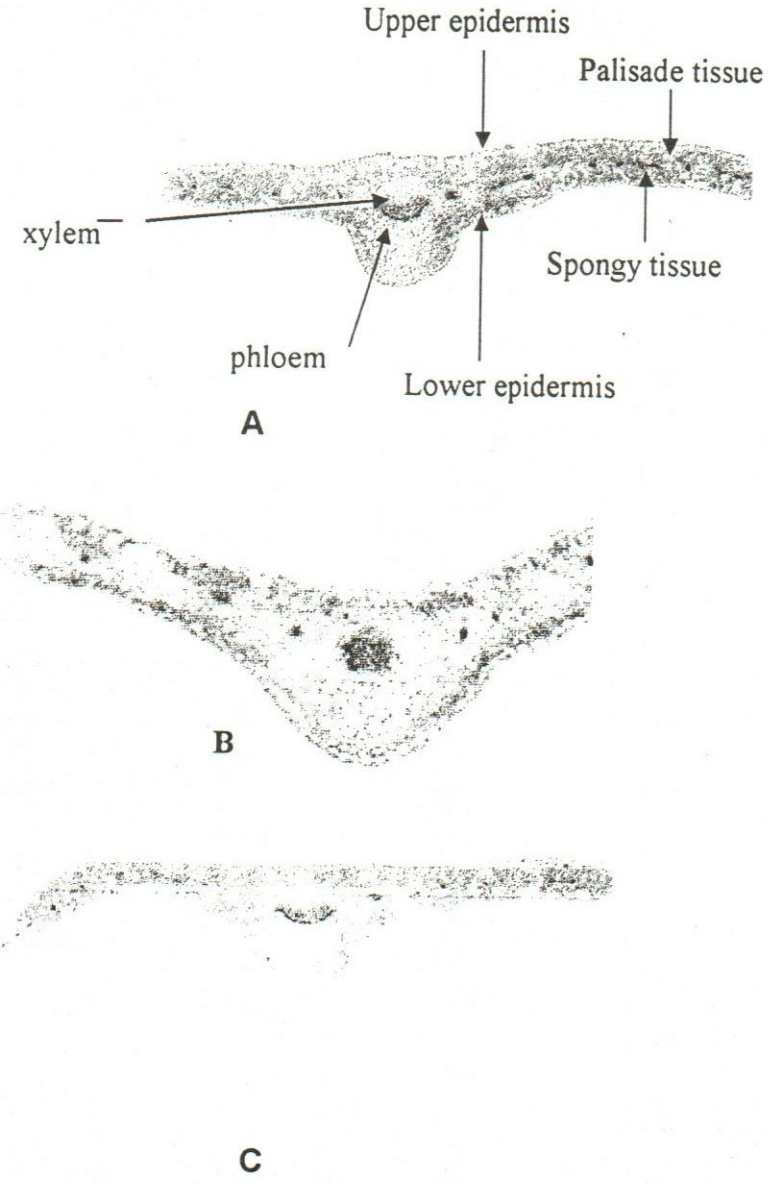

Figure (6): Transverse section in leaf blade of *G. elegans* plant grown under 3500 lux light intensity
A- control B- plants treated with GA_3 (250 ppm)
C- plants treated with NAA (200 ppm) (X 40)

As far as the authors were aware no detailed study dealing with anatomical structure of *Gypsophila* leaf was carried out. However, Metcalfe and chalk (1979) described leaves of some genera of *Caryophyllaceae* and stated that, leaf epidermis composed of cells with straight anticlinal walls, cells elongated in long leaves.Cuticle smooth, punctuate and has thickly deposited wax layer. Mid- rib in transverse section exhibiting one main vascular bundle which is not usually accompanied by sclerenchyma. Mesophyll dirsiventral, with palisade tissue occurs towards both surfaces. Centric spongy parenchyma commonly observed with large lacunae may be found in the spongy mesophyll towards the adaxial surface.

Recommendations

The most recommended outcomes from the present investigation could be summarized as follows:-

Lightening is the vital factor that enhanced *Gypsophila paniculata L.* plants for normal morphological and reproductive characteristics. Using 3500 Lux light intensity is the best stimuli factor for inducing high quality and early flowering in both gypsophila species under investigation. On the other hand, *Gypsophila elegans* plants do flowering under normal lightening conditions.

The major farm work procedure that influenced significantly flower production in both Gypsophila species is applying foliar application of 250 ppm GA3 on plants aged 30 days old and grown under 3500 Lux light intensity.

It is useless to apply NAA foliar application with *G. elegans* plants for enhancing plant morphological and reproductive characteristics. While, *G. paniculata* plants proved to be responded by different extents to NAA treatments.

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تأثير الجبريلين و نفثالين حمض الخليك وشدة الاضاءة على الصفات المورفولوجية و التشريحية والكيميائية لنباتات الجيبسوفيلا:

II- الصفات المورفولوجية و التشريحية

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اجرى هذا البحث بمحطة تجارب كلية الزراعة – جامعة القاهرة خلال موسمى ٢٠٠٢/٢٠٠٣، ٢٠٠٣/ ٢٠٠٤ وذلك بغرض دراسة تأثير مستويات مختلفة من شدة الإضاءة (١٠٥٠ ،١٨٠٠، ٣٥٠٠ لكس) والمعاملة بحمض الجبرلين بتركيزات (صفر ،٢٥٠، ٥٠٠ ، ٧٥٠ جزء فى المليون) ونفثالين حمض الخليك بتركيزات (صفر ، ٢٠٠ ،٤٠٠ ، ٦٠٠ جزء فى المليون) على الصفات المورفولوجية والتشريحية للمجموع الجذرى والخضرى لنوعين من جنس الجيبسوفيلا هما جيبسوفيلا بانكيولاتا وجيبسوفيلا اليجانس وكانت اهم النتائج المتحصل عليها هى :

أفضل معاملة للحصول على اطول نباتات من الجيبسوفيلا بانكيولاتا كانت المعاملة بالجبرالين بتركيز ٢٥٠ جزء فى المليون تحت مستوى شدة اضاءة قدره ٣٥٠٠ لكس اما فى حالة نباتات الجيبسوفيلا اليجانس فان النباتات التى عوملت بالجبرالين بتركيز ٥٠٠ جزء فى المليون و نمت تحت نفس مستوى شدة الاضاءة سجلت اطول النباتات. أتضح أنة باستخدام نفثالين حمض الخليك بتركيز ٢٠٠ جزء في المليون ومستوى شدة الاضاءة ١٨٠٠ لكس على نباتات الجيبسوفيلا بانكيولاتا واستخدامة بتركيز ٤٠٠ جزء في المليون تحت مستوى ٣٥٠٠ لكس على نباتات الجيبسوفيلا اليجانس أعطوا أعلي ارتفاع للنباتات المعاملة.

سجلت المعاملة بالجبرالين بتركيز ٢٥٠ جزء فى المليون على نباتات الجيبسوفيلا بانيكيولاتا وتركيز ٥٠٠ جزء فى المليون على نباتات الجيبسوفيلا اليجانس كلاهما تحت مستوى شدة اضاءة قدره ٣٥٠٠ لكس اكبر متوسط لعدد الفروع الاولية. وقد وجد أنه باستخدام المعاملة ٢٠٠ جزء في المليون نفثالين حمض الخليك تحت مستوى شدة الاضاءة ١٠٥٠ لكس على نباتات الجبسوفيلا بانكيولاتا و ٤٠٠ جزء في المليون تحت مستوى ١٨٠٠ لكس على نباتات الجبسوفيلا اليجانس ادت الى الحصول على اكبر عدد فروع اولية بالاضافة الى اكبر عدد من النورات. افضل عدد من النورات الزهرية لنباتات الجيبسوفيلا بانيكيولاتا تم الحصول عليه بمعاملة النباتات بالجبرالين بتركيز ٢٥٠ جزء فى المليون تحت مستوى شدة اضاءة ٣٥٠٠ لكس ، أما افضل عدد من النورات الزهرية على نباتات الجيبسوفيلا اليجانس كان مع المعاملة بالجبرالين بتركيز ٥٠٠ جزء فى المليون وتحت مستوى شدة اضاءة قدره ١٨٠٠ لكس. وقد اظهرت نباتات الجيبسوفيلا بانكيولاتا التى تعرضت لشدة اضاءة ٣٥٠٠ لكس تبكير فى التزهير الكامل بمقدار ٢٠ و ٣٥,٥ يوم عن تلك التى تعرضت لشدتى الاضاءة ١٨٠٠ و ١٠٥٠ لكس على التوالى. بينما اظهرت نباتات الجيبسوفيلا اليجانس التى تعرضت لنفس شدة الاضاءة تبكير فى التزهير الكامل بمقدار ١٦ و ٣١ يوم عن تلك التى تعرضت لشدتى الاضاءة الاخرتين. و كان أسرع تبكير فى تزهير نباتات الجيبسوفيلا تلك المعاملة بالجبرالين بتركيز ٢٥٠ جزء فى المليون والمعاملة بنفثالين حمض الخليك بتركيز ٢٠٠ جزء فى المليون تحت مستوى شدة اضاءة ٣٥٠٠ لكس عن باقي المعاملات.

اوضحت الدراسات التشريحية لكلا النوعين ان النباتات التى تمت معاملتها بنفثالين حامض الخليك تحت مستوى اضاءة ٣٥٠٠ لكس زيادة فى سمك الجذر و الساق و الورقة وترجع هذه الزيادة فى السمك الى زيادة جميع القياسات الداخلية لانسجة الجذر والساق ونصل الورقة. علي العكس أظهرت النباتات المعاملة بالجبرالين تحت نفس مستوى الاضاءة اوعية خشب ضيقة لكل من الجذر و الساق كما تسببت ايضا هذه المعاملة زيادة فى قطر الجذر ونقص فى قياسات كل من الساق ونصل الورقة.