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# RESPONSE OF CLIVIA MINIATA PLANT TO LIGHT INTENSITYAND KINETIN TREATMENTS

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## ABSTRACT

A two- year field experiment was carried out during two successive seasons of 2006/2007 & 2007/2008 to study the effect of light intensity i.e., under 40% shading net conditions (15400-16700 lux.) or under lathhouse conditions (8600-9800 lux.), kinetin treatments (50, 100 and 150 ppm) as well as their combinations on the growth, flowering and chemical composition of *Clivia miniata* plants .. The obtained results showed that plant height, number of leaves and offsets, length, width and fresh weight of leaf was greatly increased with growing Clivia plants under lathhouse conditions (shade) as compared with those grown under 40% shading net conditions (partial shade). Also, all tested applications of kinetin improved the studied vegetative growth traits, especially using the high concentration. Moreover, all combinations between light intensity and kinetin treatments caused pronounced enhancements in vegetative growth traits. However, the highest values of vegetative growth traits were produced by 150ppm kinetin sprayed plants grown under shade conditions. Growing Clivia plants under shade conditions showed to be the most promising one in inducing the earliest flowering as compared with those grown under partial shade conditions. Likewise, 100ppm kinetin-sprayed plants induced the highest precocity in this parameter. However, 100ppm kinetin-sprayed plants grown under shade condition recorded the lowest number of days to start flowering. Generally, the highest values of number of flowers/plant, number of florets/flower, length, width and fresh weight of flower were obtained by growing Clivia plants under shade conditions and sprayed with kinetin at 150ppm.

In anatomical study, as for the leaf structure is quite evident that an obvious increase was resulted by the shade condition compared with the plants grown under partial shade and increased these values due to kinetin foliar spray. Meanwhile, the thickness of cuticle and epidermis layers and vascular tissue of those grown under shade conditions were increased in comparison with the plants grown under partial shade conditions. In epidermal characteristics increased the epidermal cell dimension, stomata dimension and number of open stomata (in area 360 μ) of shade grown plants. Meanwhile, the previously mentioned characteristics were decreased in the plants grown under partial shade with increasing the total number of stomata and number of closed stomata in same area (360 μ) and the best values in anatomical structure of leaf were recorded with the shade condition and sprayed with kinetin at 150ppm. The highest values of leaf N, P, K, total chlorophylls and total indoles contents as well as the lowest leaf total phenols content were recorded by 150ppm kinetin-sprayed plants grown under shade conditions.

**Key words.** *Clivia miniata*, light intensity, Kinetin, vegetative growth, flowering, leaf anatomy and chemical composition.

## INTRODUCTION

*Clivia miniata* is a member of Family: Amaryllidaceae, *Clivia*- after the Duchess of Northumberland, Lady Charlotte Clive who first cultivated and flowered the

type specimen in England, *miniata* - colour of red lead - referring to the flowers. *Clivia miniata* is a clump forming perennial with dark green, strap shaped leaves which arise from a fleshy underground stem. The flowering heads of brilliant orange or red trumpet shaped flowers appear mainly in Spring to Summer, but also sporadically at other times of the year. The rhizomes are reportedly extremely toxic as it contains small amounts of lycorine, making it poisonous,but are used medicinally for various purposes. It can be propagated by means of seed, as well as vegetatively through offsets. It is preferable to grow under partial shade, (they are sensitive to full sunlight) (Duncan, 1999). Many authors demonstrated that growth and flowering of many ornamental bulbs can easily be forced by different growth regulators among which kinins group. Kinetin is recognized by its ability to induce cell division in certain plant tissues (Cheema and Sharma, 1982) it can also overcome the apical dominance of many plants and stimulate the lateral buds to develop into an entire new plant. Kinetin can delay senescence and cause transport of many solutes from older parts of the leaves or even from older leaves into the treated zone (Salisbury and Ross, 1974). In this respect, Shahin (1998) reported that kinetin at 75 ppm increased the values of all tested vegetative and flowering growth parameters of crinum and hemerocallis plants. Youssef (2004) indicated that 200 ppm kinetin-sprayed plants improved all studied vegetative and flowering growth traits of *Strelitzia reginae* plants. Growth and development of many plants showed variable responses resulting from planting under different light intensity as was reported by many investigators. In this respect, Hell (1996) found that in a greenhouse trial, Gerbera was shaded with 0, 30, or 70% shading, the non shaded plants showed a significant growth depression in respect to leaves and flowers/plant when compared with those grown under 30 or 50% shade. Yih and Huang (1998) planted five Lily cultivars under 50, 60 or 70% shading, and they found that vegetative and flowering growth were enhanced as the shading percentage increased when compared with plants grown under full sun light. Salama (2003) revealed that growing *Strelitzia reginae* plants under shading (range from 17430-17960 lux.) improved all studied vegetative growth and flowering traits as compared with those grown under full sun light. Plants grown in full sunlight differed from those grown in shade as follows: Leaf epidermal cells were larger, the stomata were smaller but more numerous per unit area and all leaf regions, both in the mesophyll and midvein, were larger. The ratio of the vascular area to leaf area was higher but the rate of flow in the vessels was similar (Penfound, 1931), Due to shadow effect, thicker leaf thickness and greater leaf mass per area (Bao, 2005). The effects of different light intensities on the anatomical structure and on the pigment contents in leaves of *Tradescantia pallida* cv. *purpurea*. Once light intensity became lower, the thickness of leaf lamina and mesophyll were reduced. Adjustments in light-harvesting antenna size were observed: an increase in chlorophyll a + b/carotenoids ratio at low-light growth conditions (Paiva *et al.*, 2003).

Thereupon, the present work is an attempt to enhance the flowers quality and productivity of Clivia plants under partial shade or shade conditions with the help of kinetin treatments.

## MATERIALS AND METHODS

This study was carried out at the Floriculture Nursery of the Horticulture Department, Faculty of Agriculture at Moshtohor, Benha University, during 2006/ 2007 and 2007/2008 seasons.

**Plant material:**

*Clivia miniata* bulbs (local variety with red flower) at the size of 21.32 – 24.58 cm circumference, 6.12 – 6.94 cm diameter, about 312 – 321 g weight and carry about 3-4 leaves were used in this study.

**Planting procedure:**

On September 1st of both seasons, the bulbs were planted in beds 180X180 cm as every bed contained 9 bulbs planted at 60X60 cm. and the beds were located in two places i.e., partial shade to grow under 40% shading net by using black saran (15400-16700 lux.)

and shade to grow under lathhouse (8600-9800 lux.), where the plants received the treatments of kinetin. The present work included the following treatments, partial shade and shade conditions as a main plots. Each treatment of the main plots was sprayed with kinetin at concentrations of 0.0, 50, 100 and 150 ppm three times after 60, 80 and 100 days from planting as a sub plots. Thereupon, the present work is a factorial experiment included two factors (light intensity X kinetin concentrations) as well as their combinations.

The soil in the experimental area was a clay loamy soil. The physical and chemical characteristics of the soil were shown in Tables (a and b). Mechanical analysis was estimated according to Jackson (1973), whereas, chemical analysis was estimated according to Black *et al.* (1982).

**Table (a): Mechanical analysis of the experimental soil.**

| Parameters | Unit | Seasons | |
|---|---|---|---|
| | | 2006/2007 | 2007/2008 |
| Coarse sand | % | 5.57 | 5.72 |
| Fine sand | % | 16.88 | 17.85 |
| Silt | % | 27.38 | 25.21 |
| Clay | % | 50.17 | 51.22 |
| Textural class | ---- | Clay loam | Clay loam |

**Table (b): Chemical analysis of the experimental soil.**

| Parameters | Unit | Seasons | |
|---|---|---|---|
| | | 2006/2007 | 2007/2008 |
| $CaCO_3$ | % | 1.77 | 1.86 |
| Organic matter | % | 1.78 | 1.93 |
| Available nitrogen | % | 0.89 | 0.91 |
| Available phosphorus | % | 0.12 | 0.13 |
| Available potassium | % | 0.69 | 0.71 |
| EC | ds/m | 1.42 | 1.48 |
| pH | ---------- | 7.84 | 7.99 |

After two months from planting the plants were fertilized with NPK using ammonium sulfate (20.5% N), calcium superphosphate (15.5% $P_2O_5$) and potassium sulfate (48% $K_2O$). A mixture of the three fertilizers, with a ratio of 1 : 1 : 1 (N : $P_2O_5$ : $K_2O$), was prepared and applied to the experimental area at the rate of 50 g/m$^2$. Common agricultural practices (irrigation, manual weed control, . . . etc.) were carried out when needed.

**Experiment layout:**

The design of the experiment was a split plot design with eight treatments (two light intensity levels x four kinetin concentrations) replicated 3 times (each replicate consisted of three beds, with 9 bulbs/bed). The treatments of light intensity were assigned to the main plots, whereas kinetin treatments were employed to the sub plots.

**Data recorded:**

**I- Vegetative growth measurements:**

plant height (cm), number of leaves and offsets/plant, length, width and fresh weight of leaf (at the beginning of flowering).

**II- Flowering growth measurements:**

Flowering date (number of days from planting till first floret showing color), number of flowers/plant, number of florets/flower, duration of flower on plant, length and fresh weight of flower.

**III-Anatomical study:**

The samples of leaf were taken from the 4$^{th}$ leaf from top and the samples were taken from all treatments added with the control. The specimens were taken then killed and fixed in FAA (5ml. formalin, 5ml. glacial acetic acid and 90ml. ethyl alchohol 70%),

washed in 50% ethyl alcohol, dehydrated in series of ethyl alchohols 70,90,95 and 100%, infiltrated in xylene, embedded in paraffin wax with a melting point of 60-63°C, sectioned to 20 microns in thickness (Sass 1951), stained with the double stain method (fast green and safranin), cleared in xylene and mounted in Canada balsam (Johanson, 1940). Sections were read to detect histological manifestation of noticeable responses resulted from other treatments. Hence, leaf stomatal characteristics i.e., stomatal density (number of stomata per leaf area unit/360μ and stomatal pore dimensions (length and width)) for the upper leaf surface were determined from impressions of the leaf surface on transparent fingernail polish according to methods described by Stoddard (1965) and Manning *et al.* (1977) and Laz (1999).

**IV- Chemical analysis:**

- Total nitrogen percentage was determined in the dried leaves by using wet digestion according to Piper (1947), using micro-kjeldahl method as described by Horneck and Miller (1998).
- Phosphorus percentage was determined calorimetrically in spectronic (20) spectrophotometer using the method described by Sandell (1950).
- Potassium content was determined by flame photometer according to Horneck and Hanson (1998).
- Total carbohydrates content was determined in dry leaf powder according to Herbert *et al.* (1971).
- Total chlorophylls was determined in leaf samples (mg/100g FW) by using colorimetric method (A.O.A.C, 1990)

**-Total soluble indoles:**

Total soluble indoles were determined using colorimetric method (A.O.A.C, 1990) using standard curve of indole acetic acid.

**- Total soluble phenols:**

Total soluble phenols were determined by using folindenis colorimetric method (A.O. A.C, 1990), using a standard curve of pyrogallol.

**Statistical analysis:**

All data obtained in both seasons of the study were subjected to analysis of variance as a factorial experiment in split plot design. LSD method at 5% level was used to differentiate between means according to Snedecor and Cochran (1989).

## RESULTS AND DISCUSSION

**Effect of light intensity and kinetin treatments on vegetative growth, flowering and chemical composition of *Clivia miniata* plants**

**I- Vegetative growth measurements:**

Data obtained for vegetative growth measurements i.e., plant height, number of leaves, number of offsets, leaf length, leaf width and fresh weight of leaf as affected by light intensity i.e., partial shade "15400-16700 lux." or shade " 8600-9800 lux." and kinetin treatments i.e., 0.0 ppm (control), 50 ppm, 100 ppm and 150 ppm as well as their combinations are presented in Tables (1 & 2). The data show that growing Clivia plants under shade was more effective than those grown under partial shade concerning increasing the values of plant height, number of leaves and offsets, length, width and fresh weight of leaf in both seasons.

Regarding the effect of the tested kinetin concentrations, it was interested to note that there was a positive relationship between vegetative growth measurements and kinetin concentrations. Hence, as the concentration of kinetin increased, the values of vegetative growth measurements increased to reach the maximum increasing at the high concentration (150ppm). Therefore, 150ppm kinetin- sprayed plants statistically scored the highest values of plant height, number of leaves, number of offsets, leaf length, leaf width and leaf fresh weight when compared with untreated plants "control" in both seasons. As for the interaction effect between light intensity and kinetin treatments, it was obvious that all resulted combinations succeeded in increasing the values of vegetative growth measurements as compared with control in both seasons. Generally, the highest values of plant height, number of leaves,

number of offsets, leaf length, leaf width and leaf fresh weight were recorded by 150ppm kinetin- treated plants grown under shade when compared with the remaining treatments and control in the first and second seasons.

**Table (1): Effect of light intensity and kinetin treatments on plant height (cm), number of leaves and offsets/plant of *Clivia miniata* plant during the two seasons of 2006/2007 and 2007/2008.**

| Season | | First season (2006/2007) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | | Plant height | | | No. of leaves | | | No. of offsets | | |
| Light intensity / Kinetin | | Shade | Partial shade | Mean | Shade | Partial shade | Mean | Shade | Partial shade | Mean |
| Control | | 75.6 | 54.9 | 65.3 | 17.3 | 12.3 | 14.8 | 1.92 | 1.73 | 1.83 |
| Kinetin at 50 ppm | | 79.8 | 59.6 | 69.7 | 20.9 | 15.1 | 18.00 | 2.36 | 1.94 | 2.15 |
| Kinetin at 100 ppm | | 86.3 | 65.3 | 75.8 | 25.8 | 17.3 | 21.6 | 2.96 | 2.12 | 2.54 |
| Kinetin at 150 pm | | 92.8 | 69.8 | 81.3 | 28.7 | 19.2 | 24.0 | 3.11 | 2.27 | 2.69 |
| Mean | | 83.6 | 62.4 | | 23.2 | 16.00 | | 2.58 | 2.02 | |
| L.S.D at 0.05 | For light intensity | 12.36 | | | 4.24 | | | 0.33 | | |
| | For kinetin | 3.42 | | | 2.82 | | | 0.24 | | |
| | For the interaction | 4.91 | | | 3.67 | | | 0.27 | | |
| Second season (2007/2008) | | | | | | | | | | |
| Control | | 72.9 | 57.3 | 65.1 | 19.7 | 13.9 | 16.8 | 1.96 | 1.80 | 1.88 |
| Kinetin at 50 ppm | | 78.3 | 63.0 | 70.7 | 23.5 | 17.6 | 20.6 | 2.44 | 1.99 | 2.22 |
| Kinetin at 100 ppm | | 85.7 | 69.6 | 77.7 | 29.1 | 17.2 | 23.2 | 3.08 | 1.96 | 2.52 |
| Kinetin at 150 ppm | | 89.5 | 73.4 | 81.5 | 32.3 | 20.4 | 26.4 | 3.18 | 2.23 | 2.71 |
| Mean | | 81.6 | 65.8 | | 26.2 | 17.3 | | 2.67 | 2.00 | |
| L.S.D at 0.05 | For light intensity | 11.57 | | | 519 | | | 0.43 | | |
| | For kinetin | 4.62 | | | 3.40 | | | 0.21 | | |
| | For the interaction | 6.13 | | | 4.02 | | | 0.29 | | |

**Table (2): Effect of light intensity and kinetin treatments on leaf length, leaf width and leaf fresh weight of *Clivia miniata* plant during the two seasons of 2006/2007 and 2007/2008.**

| Season | | First season (2006/2007) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | | Leaf length (cm) | | | Leaf width (cm) | | | leaf fresh weight (g) | | |
| Light intensity / Kinetin | | Shade | Partial shade | Mean | Shade | Partial shade | Mean | Shade | Partial shade | Mean |
| Control | | 64.2 | 45.8 | 55.0 | 4.38 | 4.01 | 4.20 | 38.6 | 31.2 | 34.9 |
| Kinetin at 50 ppm | | 69.4 | 49.3 | 59. 4 | 4.46 | 4.13 | 4.30 | 40.2 | 32.9 | 36.6 |
| Kinetin at 100 ppm | | 74.9 | 55.1 | 65.0 | 4.63 | 4.20 | 4.42 | 43.9 | 38.3 | 41.1 |
| Kinetin at 150 ppm | | 77.8 | 59.4 | 68.6 | 4.81 | 4.23 | 4.52 | 47.8 | 39.2 | 43.5 |
| Mean | | 71.6 | 52.4 | | 4.57 | 4.14 | | 42.6 | 35.4 | |
| L.S.D at 0.05 | For light intensity | 11.45 | | | 0.25 | | | 3.15 | | |
| | For kinetin | 3.84 | | | 0.08 | | | 1.69 | | |
| | For the interaction | 5.64 | | | 0.19 | | | 2.99 | | |
| Second season (2007/2008) | | | | | | | | | | |
| Control | | 62.4 | 47.3 | 54.9 | 4.41 | 4.11 | 4.26 | 35.7 | 32.9 | 34.3 |
| Kinetin at 50 ppm | | 66.5 | 51.2 | 58.9 | 4.53 | 4.29 | 4.41 | 39.6 | 35.7 | 37.7 |
| Kinetin at 100 ppm | | 72.3 | 57.6 | 65.0 | 4.79 | 4.26 | 4.53 | 41.5 | 39.8 | 40.7 |
| Kinetin at 150 ppm | | 74.8 | 61.2 | 68.0 | 4.98 | 4.32 | 4.65 | 43.9 | 42.3 | 43.1 |
| Mean | | 69.0 | 54.3 | | 4.68 | 4.25 | | 40.2 | 37.7 | |
| L.S.D at 0.05 | For light intensity | 8.17 | | | 0.21 | | | 1.83 | | |
| | For kinetin | 3.11 | | | 0.16 | | | 1.54 | | |
| | For the interaction | 4.30 | | | 0.21 | | | 2.39 | | |

Partial shade (under 40% shading net conditions: 15400-16700 lux.). Shade (under lath house conditions: 8600-9800 lux.)

These results might be due to the role of kinetin in promoting protein synthesis, increasing cell division and enlargement (Cheema and Sharma, 1982). Moreover, These results might be explained according to the role of kinetin in promoting proteins, soluble and non-soluble sugars synthesis, or may be due to the ability of kinetin for making the treated area to act as a sink into which nutrients from other parts of the plant are drawn (Salisbury and Ross, 1974).

The aforementioned results of kinetin are in conformity with those attained by Runkova (1985) on *Dhalia pinnata*, Criley (1988) on Strelitzia, Alpinia and Heliconia, Auda (1992) on *Hippeastrum vittatum*, Maximoos (1993) on *Gerbera jamesonii* and Youssef (2004) who indicated that spraying *Strelitzia reginae* plants with kinetin at 100 and 200 ppm increased number of leaves and offsets/plants, the length and thickness of leaf petiole and their fresh and dry weights. The abovementioned results of light intensity are in harmony with those attained by Hell (1996) on Gerbera plant, Yih and Huang (1998) on five Lily cultivars and Salama (2003) revealed that grown *Strelitzia reginae* plants under shading (range from 17430-17960 lux.) improved all studied vegetative growth traits i.e., number of leaves and offsets, fresh and dry weights of leaves as compared with those grown under full sun light.

**II- Flowering growth measurements:**

Data of the time to the first floret showing color as an indicator of flowering date by days determined from the beginning of planting date, September 1st, in the two seasons, are shown in Table (3). Data reveal that growing Clivia plants under shade conditions approved to be the most promising one in inducing the earliest flowering when compared with those grown under partial shade conditions.

Regarding the effect of kinetin concentrations, it was observed that all tested kinetin applications statistically decreased the number of days required to start flowering, especially the medium concentration (100 ppm), followed in descending order by the highest concentration (150 ppm) and finally the lowest one (50 ppm) as compared with control in both seasons. As for the interaction effect between light intensity and kinetin treatments, it was found that all tested combinations succeeded in advancing flowering date when compared with control in both seasons. However, the earliest flowering date of Clivia plants was scored by 100ppm kinetin-sprayed plants grown under shade conditions as compared with control and the rest treatments in both seasons. With respect to number of flowers/plants, number of florets/flower, duration of flower on plant, flower length and flower fresh weight, data in Tables (3 & 4) show that growing Clivia plants under shade conditions was more effective than growing under partial shade conditions concerning increasing the values of number of flowers/plant, number of florets/flower, duration of flower on plant, flower length and flower fresh weight in both seasons.

Referring to the effect of kinetin concentrations, data in Tables (3 & 4) indicate that all tested kinetin concentrations succeeded in improving flowering growth measurements. The improvements of flowering growth were in parallel with the tested kinetin concentrations, so the highest values of flowering growth measurements were recorded by the high kinetin concentration, followed descendingly by using the medium concentration. Concerning the interaction effect between light intensity and kinetin treatments, data in Tables (3 & 4) indicate that all resulted combinations caused an increases in flowering growth measurements. In general, 150 ppm kinetin- sprayed plants grown under shade conditions showed to be the most effective treatment in inducing the highest values of number of flowers/plant, number of florets/flower, duration of flower on plant, flower length and flower fresh weight in both seasons. These results might be explained according to the role of kinetin in promoting proteins, soluble and non-soluble sugars synthesis, or may be due to the ability of kinetin for making the treated area to act as a sink into which nutrients from other parts of the plant are drawn. Additionally, These

results may explain the role of cytokinins on promoting proteins and pigments synthesis and their ability to delay senescence and withdraw sugars and other solutes from older parts of a plant to the new organs (Salisbury and Ross, 1974). In the same line Leopol and Kawase (1964) stated that cytokinins stimulate the movement of sugars, starch, amino acids and many other solutes from mature organs to primary tissues of other ones. Furthermore, it may be due to the role of kinetin in increasing the promoters level in the plant tissues at the expense of the inhibitors to induce flowering. The abovementioned results of kinetin are in harmony with those reported by Runkova (1985) on *Helenium sp* and *Dahlia pinnata*, Tjia (1986) on *Zantedeschia elliotiana*, Nabih and Sakr (1991) on Freesia, Auda (1992) on *Hippeastrum vittatum*, Maximoos (1993) on *Gerbera jamesonii*, Khalafalla *et al.*, (1995) on *Dahlia pinnata* and Shahin (1998) who mentioned that treated Crinum and Hemerocallis plants with kinetin at 50 and 75 ppm significantly increased the number of flowers, length and thickness of flower stalk as well as their fresh and dry weights. The aforementioned results of light intensity are in conformity with those obtained by Hell (1996) on Gerbera plant, Yih and Huang (1998) on five Lily cultivars and Salama (2003) who reported that growing *Strelitzia reginae* plants under shading (range from 17430-17960 lux.) increased the number, length, fresh and dry weights of flowers/plant as compared with those grown under full sun light.

**III-Anatomical study:**

**a-Leaf structure:**

As shown in Table (5) and Figures (1&2) Clivia plants grown under shade were better than those grown under partial shade concerning the higher values of certain anatomical characteristics e.g., leaf blade thickness, number & thickness of spongy tissue, thickness of xylem & phloem tissues, vascular bundle length and thickness of the widest xylem vessel in vascular bundle. Meanwhile, the plants grown under partial shade showed higher values in the cuticle layer & epidermal layer thickness, length of vascular bundle, xylem thickness, number of vessels and thickness of widest xylem vessel in vascular bundle than those grown under shade conditions. As for the leaf structure, it is quite evident that an obvious increase was existed in most studied characteristics in leaf blade by the shade and kinetin foliar spray. Such increase was clearly observed in the plants grown under the shade and kinetin foliar spray at 150 ppm.

**b- Epidermal characteristics:**

The different investigated epidermal characteristics were per leaf area unit/360μ as shown from Table (6), data show that grown Clivia plants under shade conditions increased the stomatal characteristics, especially epidermal cell dimensions (length and width) and stomatal dimensions (length and width) compared with those grown under partial shade. Meanwhile, the number of total stomata and number of open stomata per leaf area unit/360μ, were decreased relatively in these traits. Also, the control plants grown under the shade conditions recorded increment in epidermal cell dimensions reached to 158.40 and 25.20 μ for length and width, respectively and 55.80 and 36.70 μ for length and width of stomatal dimensions, respectively. Meanwhile, the control plants grown under partial shade conditions recorded 90.00 and 27.00 μ for length and width of epidermal cell dimensions, and 46.00 and 23.22 μ for length and width of stomatal dimensions, respectively.

Also, data show that the studied characteristics varied in their response to kinetin spray. Since, the epidermal characteristics were increased with increasing the concentration of kinetin to reach their maximum values with the highest concentration (150ppm) especially, in the Clivia plants grown under shade.

Generally, the effect of light on leaf structure resulted from increase cell sap concentration due to increasing the photosynthetic rate, accumulation the sugars in the cells and increased the transpiration rate leading to possible damage in some tissues reversing up to growth weakness in such plants known to be sensitive for full sun light (Gorischeva, 1979; Fahn,1990 and Glover, 2000).

**Table (3): Effect of light intensity and kinetin treatments on flowering date (days), number of flowers/plant and number of florets/flower of *Clivia miniata* plant during the two seasons of 2006/2007 and 2007/2008.**

| Season | | First season (2006/2007) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | | Flowering date | | Mean | No. of flowers/plant | | Mean | No. of florets/flower | | Mean |
| Light intensity / Kinetin | | Shade | Partial shade | | Shade | Partial shade | | Shade | Partial shade | |
| Control | | 243.2 | 249.6 | 246.4 | 1.43 | 1.12 | 1.28 | 27.4 | 21.1 | 24.3 |
| Kinetin at 50 ppm | | 236.4 | 245.3 | 240.9 | 1.96 | 1.36 | 1.66 | 29.8 | 25.3 | 27.6 |
| Kinetin at 100 ppm | | 222.5 | 238.2 | 233.9 | 2.11 | 1.42 | 1.77 | 33.7 | 27.9 | 30.8 |
| Kinetin at 150 ppm | | 229.6 | 239.7 | 231.1 | 2.83 | 1.85 | 2.34 | 36.2 | 29.6 | 32.9 |
| Mean | | 232.9 | 243.2 | | 2.08 | 1.44 | | 31.8 | 26.0 | |
| L.S.D at 0.05 | For light intensity | 12.30 | | | 0.32 | | | 2.49 | | |
| | For kinetin | 4.26 | | | 0.26 | | | 2.11 | | |
| | For the interaction | 7.58 | | | 0.31 | | | 2.36 | | |
| | | Second season (2007/2008) | | | | | | | | |
| Control | | 239.6 | 246.2 | 242.9 | 1.51 | 1.20 | 1.36 | 25.2 | 19.6 | 22.4 |
| Kinetin at 50 ppm | | 231.7 | 243.0 | 237.4 | 1.87 | 1.43 | 1.65 | 27.6 | 22.5 | 25.1 |
| Kinetin at 100 ppm | | 219.1 | 240.9 | 232.7 | 2.33 | 1.49 | 1.91 | 29.3 | 28.1 | 28.7 |
| Kinetin at 150 ppm | | 224.5 | 237.8 | 228.5 | 2.76 | 1.88 | 2.32 | 32.9 | 27.8 | 30.4 |
| Mean | | 228.7 | 242.0 | | 2.12 | 1.50 | | 28.8 | 24.5 | |
| L.S.D at 0.05 | For light intensity | 9.14 | | | 0.37 | | | 2.53 | | |
| | For kinetin | 5.21 | | | 0.25 | | | 2.01 | | |
| | For the interaction | 6.17 | | | 0.29 | | | 2.93 | | |

**Table (4): Effect of light intensity and kinetin treatments on duration of flower on plant (days), flower length and flower fresh weight of *Clivia miniata* plant during the two seasons of 2006/2007 and 2007/2008.**

| Season | | First season (2006/2007) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | | Duration of flower | | Mean | Flower length (cm) | | Mean | Flower fresh weight (g) | | Mean |
| Light intensity / Kinetin | | Shade | Partial shade | | Shade | Partial shade | | Shade | Partial shade | |
| Control | | 21.8 | 17.1 | 19.5 | 62.9 | 43.9 | 53.4 | 83.4 | 58.3 | 70.9 |
| Kinetin at 50 ppm | | 25.3 | 21.9 | 23.6 | 65.3 | 49.7 | 57.5 | 89.7 | 64.8 | 77.3 |
| Kinetin at 100 ppm | | 31.6 | 20.7 | 26.2 | 69.7 | 48.3 | 59.0 | 98.3 | 69.2 | 83.8 |
| Kinetin at 150 ppm | | 34.8 | 23.6 | 29.2 | 75.3 | 53.6 | 64.5 | 105.6 | 78.3 | 92.0 |
| Mean | | 28.4 | 20.8 | | 68.3 | 48.9 | | 94.3 | 67.7 | |
| L.S.D at 0.05 | For light intensity | 5.03 | | | 9.60 | | | 12.80 | | |
| | For kinetin | 3.29 | | | 3.33 | | | 5.76 | | |
| | For the interaction | 4.20 | | | 3.87 | | | 7.03 | | |
| | | Second season (2007/2008) | | | | | | | | |
| Control | | 23.4 | 19.3 | 21.4 | 59.7 | 41.7 | 50.7 | 76.8 | 53.9 | 65.4 |
| Kinetin at 50 ppm | | 28.5 | 21.7 | 25.1 | 64.1 | 44.2 | 54.2 | 82.7 | 59.0 | 70.9 |
| Kinetin at 100 ppm | | 27.9 | 23.6 | 25.8 | 67.9 | 47.7 | 57.8 | 89.3 | 66.1 | 77.7 |
| Kinetin at 150 ppm | | 31.4 | 25.0 | 28.2 | 73.8 | 50.6 | 62.2 | 97.6 | 72.8 | 85.2 |
| Mean | | 27.8 | 22.4 | | 66.4 | 46.1 | | 86.6 | 63.0 | |
| L.S.D at 0.05 | For light intensity | 3.92 | | | 8.41 | | | 13.09 | | |
| | For kinetin | 2.78 | | | 3.79 | | | 4.98 | | |
| | For the interaction | 3.50 | | | 3.90 | | | 5.30 | | |

Partial shade (under 40% shading net conditions: 15400-16700 lux.). Shade (under lath house conditions: 8600-9800 lux.).

**Table (5): Effect of light intensity and kinetin on histological characteristics of Clivia plant leaf (2007/2008, season).**

| Treatments / Histological characteristics(microns) | Shade | | | | Partial shade | | | |
|---|---|---|---|---|---|---|---|---|
| | Control | Kinetin at 50 ppm | Kinetin at 100 ppm | Kinetin at 150 ppm | Control | Kinetin at 50 ppm | Kinetin at 100 ppm | Kinetin at 150 ppm |
| Thickness of blade. | 2735.20 | 2821.33 | 2890.53 | 2961.06 | 1871.73 | 2392.20 | 2565.05 | 2861.73 |
| Upper epidermal cuticle thickness. | 11.00 | 11.70 | 13.50 | 15.30 | 13.50 | 15.75 | 16.40 | 20.25 |
| Lower epidermal cuticle thickness. | 9.00 | 9.90 | 11.70 | 11.76 | 13.05 | 13.50 | 15.30 | 15.75 |
| Upper epidermal thickness. | 46.35 | 46.80 | 49.50 | 54.00 | 51.30 | 53.55 | 55.35 | 58.05 |
| Lower epidermal thickness. | 32.85 | 42.93 | 43.83 | 45.00 | 37.08 | 43.20 | 49.50 | 49.68 |
| Thickness of spongy tissue. | 2636.00 | 2710.00 | 2772.00 | 2835.00 | 1756.80 | 2266.20 | 2428.50 | 2718.00 |
| Number of spongy tissue layers. | 36.00 | 36.50 | 37.00 | 39.00 | 25.00 | 31.00 | 36.00 | 37.00 |
| Mean thickness of spongy tissue layer. | 73.22 | 74.25 | 74.92 | 72.69 | 70.27 | 73.10 | 67.46 | 73.46 |
| Number of chloronchyma layers in spongy tissue under the upper epidermis. | 6.00 | 6.00 | 7.00 | 7.00 | 5.00 | 6.00 | 6.00 | 7.00 |
| Number of chloronchyma layers in spongy tissue above the upper epidermis. | 8.00 | 9.00 | 9.60 | 10.00 | 8.00 | 9.00 | 10.00 | 11.00 |
| Length of vascular bundle. | 343.80 | 389.70 | 439.20 | 441.00 | 432.00 | 445.50 | 459.00 | 467.10 |
| Thickness of phloem in vascular bundle | 153.00 | 153.90 | 155.30 | 182.70 | 162.00 | 191.70 | 192.60 | 197.10 |
| Thickness of xylem in vascular bundle. | 156.60 | 159.30 | 182.25 | 205.20 | 126..90 | 175.50 | 185.40 | 205.60 |
| Number of vessels in the vascular bundle. | 5.00 | 10.00 | 10.00 | 15.00 | 8.00 | 11.00 | 14.00 | 15.00 |
| Thickness of widest xylem vessel in vascular bundle. | 39.60 | 41.40 | 47.70 | 51.75 | 38.25 | 44.55 | 45.90 | 56.25 |

**Table (6): Effect of light intensity and kinetin on stomatal characteristics of epidermal leaf in Clivia plant (2007/2008, season).**

| Treatments / Epidermal characteristics(microns | The shade | | | | Partial shade | | | |
|---|---|---|---|---|---|---|---|---|
| | Control | Kinetin at 50 ppm | Kinetin at 100 ppm | Kinetin at 150 ppm | Control | Kinetin at 50 ppm | Kinetin at 100 ppm | Kinetin at 150 ppm |
| Length of the epidermal cell. | 158.40 | 166.80 | 169.30 | 176.40 | 90.00 | 94.50 | 127.35 | 169.80 |
| Width of the epidermal cell. | 25.20 | 29.70 | 34.20 | 42,30 | 27.00 | 30.60 | 34.42 | 39.60 |
| Number of total stomata per leaf area unit/360μ. | 3.50 | 3.00 | 3.50 | 2.50 | 3.50 | 2.50 | 4.00 | 5.00 |
| Number of open stomata per leaf area unit/360μ. | 2.50 | 2.50 | 3.50 | 2.50 | 0.50 | 0.00 | 1.00 | 1.67 |
| Number of close stomata per leaf area unit/360μ. | 1.00 | 0.50 | 0.50 | 0.00 | 3.00 | 2.50 | 3.00 | 3.33 |
| Length of the stomata. | 55.80 | 56.25 | 58.50 | 62.12 | 46.00 | 46.80 | 46.80 | 50.30 |
| Width of the stomata. | 36.70 | 37.80 | 43.20 | 48.60 | 23.22 | 30.60 | 31.50 | 39.60 |

Several researches have demonstrated that exposing the plants to light in excess may cause damage to the photosynthetic apparatus and that photosynthetic organisms present a few mechanisms for photo protection within the chloroplast, regulation of photosynthetic light harvesting, and electron transport balances the absorption and utilization of light energy. For example, adjustments in light-harvesting antenna size and photosynthetic capacity can decrease light absorption and increase light utilization, respectively, during relatively longterm acclimation to excessive light (Niyogi, 1999). These pigments have been associated to the protection of the photosynthetic apparatus against the actions of oxygen free radicals (Krause, 1988), whose production increases under high light intensities.

The same results were obtained by Wilson and Cooper (1969) in lolium; Sims and Pearcy (1992) in *Alocasia macrorrhiza;* Paiva *et al.* (2003) in *Tradescantia pallida* (Rose) Hunt. cv. *purpurea* Boom (Commelinaceae) leaves; Bao (2005)

**IV-Chemical composition determinations:**

Data in Tables (7 & 8) show that growing Clivia plants under shade conditions was greatly effective than those grown under partial shade regarding increasing leaf N, P, K, total chlorophylls and total indoles contents. On contrary, growing Clivia plants under shade conditions was more effective than those grown in partial shade in decreasing leaf total phenols content in both seasons. Moreover, leaf N, P, K, total chlorophylls and total indoles content (%) progressively increased with increasing the concentration of kinetin to reach their maximum values at the highest concentration in both seasons. On the reverse, all tested applications of kinetin decreased leaf total phenols content (%). The decreases in leaf total phenols content were in parallel to the increasing of kinetin concentration in both seasons.

**Table (7) : Effect of light intensity and kinetin treatments on leaves N, P and K% content of *Clivia miniata* plant during the two seasons of 2006/2007 and 2007/2008.**

| Season | | First season (2006/2007) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | | N% | | | P% | | | K% | | |
| Light intensity / Kinetin | | Shade | Partial shade | Mean | Shade | Partial shade | Mean | Shade | Partial shade | Mean |
| Control | | 3.02 | 2.83 | 2.93 | 0.14 | 0.12 | 0.13 | 1.46 | 1.31 | 1.39 |
| Kinetin at 50 ppm | | 3.23 | 2.97 | 3.10 | 0.15 | 0.11 | 0.13 | 1.63 | 1.36 | 1.50 |
| Kinetin at 100 ppm | | 3.18 | 3.32 | 3.25 | 0.17 | 0.14 | 0.16 | 1.59 | 1.49 | 1.54 |
| Kinetin at 150 ppm | | 3.46 | 3.29 | 3.38 | 0.19 | 0.14 | 0.17 | 1.78 | 1.48 | 1.63 |
| Mean | | 3.22 | 3.10 | | 0.16 | 0.13 | | 1.62 | 1.41 | |
| L.S.D at 0.05 | For light intensity | 0.11 | | | 0.021 | | | 0.092 | | |
| | For kinetin | 0.12 | | | 0.012 | | | 0.14 | | |
| | For the interaction | 0.17 | | | 0.020 | | | 0.15 | | |
| Second season (2007/2008) | | | | | | | | | | |
| Control | | 3.15 | 2.97 | 3.06 | 0.13 | 0.11 | 0.12 | 1.43 | 1.29 | 1.36 |
| Kinetin at 50 ppm | | 3.29 | 3.27 | 3.28 | 0.16 | 0.12 | 0.14 | 1.52 | 1.37 | 1.45 |
| Kinetin at 100 ppm | | 3.38 | 3.20 | 3.29 | 0.15 | 0.12 | 0.14 | 1.63 | 1.32 | 1.48 |
| Kinetin at 150 ppm | | 3.56 | 3.36 | 3.46 | 0.17 | 0.14 | 0.16 | 1.71 | 1.40 | 1.56 |
| Mean | | 3.35 | 3.20 | | 0.15 | 0.12 | | 1.57 | 1.35 | |
| L.S.D at 0.05 | For light intensity | 0.14 | | | 0.021 | | | 0.12 | | |
| | For kinetin | 0.15 | | | 0.014 | | | 0.11 | | |
| | For the interaction | 0.18 | | | 0.015 | | | 0.13 | | |

Partial shade (under 40% shading net conditions: 15400-16700 lux.). Shade (under lath house conditions: 8600-9800 lux.).

**Table (8): Effect of light intensity and kinetin treatments on total chlorophylls, total phenols and total indoles (mg/100g f.w.) of *Clivia miniata* plant during the two seasons of 2006/2007 and 2007/2008.**

| Season | | First season (2006/2007) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | | Total chlorophylls | | Mean | Total phenols | | Mean | Total indoles | | Mean |
| Light intensity / Kinetin | | Shade | Partial shade | | Shade | Partial shade | | Shade | Partial shade | |
| Control | | 246.3 | 213.6 | 230.0 | 185.9 | 246.5 | 216.2 | 214.6 | 143.7 | 179.2 |
| Kinetin at 50 ppm | | 257.2 | 225.4 | 241.3 | 173.6 | 238.1 | 205.9 | 231.4 | 169.2 | 200.3 |
| Kinetin at 100 ppm | | 273.0 | 236.2 | 254.6 | 162.4 | 229.0 | 195.7 | 244.0 | 158.4 | 201.2 |
| Kinetin at 150 ppm | | 281.9 | 229.8 | 255.9 | 159.3 | 221.8 | 190.6 | 249.8 | 172.6 | 211.2 |
| Mean | | 264.6 | 226.3 | | 170.3 | 233.6 | | 235.0 | 161.0 | |
| L.S.D at 0.05 | For light intensity | 21.34 | | | 27.03 | | | 32.35 | | |
| | For kinetin | 9.26 | | | 10.15 | | | 18.14 | | |
| | For the interaction | 12.70 | | | 12.70 | | | 21.20 | | |
| Second season (2007/2008) | | | | | | | | | | |
| Control | | 253.4 | 219.3 | 236.4 | 192.6 | 261.7 | 227.2 | 204.3 | 131.5 | 167.9 |
| Kinetin at 50 ppm | | 271.9 | 228.7 | 250.3 | 184.0 | 243.1 | 213.6 | 211.9 | 152.0 | 182.0 |
| Kinetin at 100 ppm | | 268.4 | 239.5 | 254.0 | 169.3 | 246.4 | 207.9 | 224.2 | 149.3 | 186.8 |
| Kinetin at 150 ppm | | 289.0 | 242.7 | 265.9 | 162.7 | 233.0 | 197.9 | 236.8 | 157.1 | 197.0 |
| Mean | | 270.7 | 232.6 | | 177.2 | 246.1 | | 219.3 | 147.5 | |
| L.S.D at 0.05 | For light intensity | 18.08 | | | 31.22 | | | 38.56 | | |
| | For kinetin | 12.43 | | | 12.60 | | | 15.23 | | |
| | For the interaction | 16.50 | | | 14.35 | | | 17.70 | | |

Partial shade (under 40% shading net conditions: 15400-16700 lux.). Shade (under lath house conditions: 8600-9800 lux.).

So, the lowest leaf total phenols content (%) was recorded by using the highest concentration of kinetin in both seasons. As for the interaction effect between light intensity and kinetin treatments, it was obvious from Tables (7 & 8) that all resulted combinations succeeded in increasing leaf N, P, K, total chlorophylls and total indoles contents. On the opposite, all tested combinations of light intensity and kinetin treatments decreased leaf total phenols content (%) in both seasons. In general, the highest leaf N, P, K, total chlorophylls and total indoles contents (%) as well as the lowest leaf total phenols content (%) were obtained by 150ppm kinetin-sprayed plants grown under lath house conditions in both seasons.

These results may explain the role of cytokinins on promoting proteins and pigments synthesis and their ability to delay senescence and withdraw sugars and other solutes from older parts of a plant to the new organs (Salisbury and Ross, 1974). In the same line Leopol and Kawase (1964) stated that cytokinins stimulate the movement of sugars, starch, amino acids and many other solutes from mature organs to primary tissues of other ones. Furthermore, may be due to the role of kinetin in increasing the promoters in the plant tissues at the expense of the inhibitors. In this concern, Kenneth (1979) reported that the total control of plant growth is vested not in a single hormonal type – that of auxin – but is shared by several specially auxins, cytokinins, gibberellins and ethylene and this further subjected to namely the phenols, flavons and absicsic acid. The aforementioned results of kinetin are in conformity with those obtained by Awad *et al.* (1980) on *Gladiolus communis*, Fikry (1983) on *Chrysanthemum morifolium*, Al-Moulla (1989) on Croton, Maximoos (1993) on *Gerbera jamesonii*, Shahin (1998) on Crinum and

Hemerocallis plants and Youssef (2004) who revealed that spraying *Strelitzia reginae* plants with kinetin at 100 and 200 ppm significantly increased leaf N, P, K, total chlorophylls and total indoles contents, but it decreased leaf total phenols content. The abovementioned results of light intensity are in harmony with those obtained by Hell (1996) on Gerbera plant, Yih and Huang (1998) on five Lily cultivars and Salama (2003) indicated that grown *Strelitzia reginae* plants under shading (range from 17430-17960 lux.) increased leaf N, P, K, and total chlorophylls contents as compared with those grown under full sun light.

Conclusively, in order to produce early flowered *Clivia miniata* plants with higher flowers number, longer flower stalk and higher number of florets/flower, it is preferable to grow the plants under shade conditions and sprayed with kinetin at 100 or 150 ppm . Additionally, the plants that grown under partial shade conditions could give the previously mentioned prospective traits when supported with kinetin treatments .

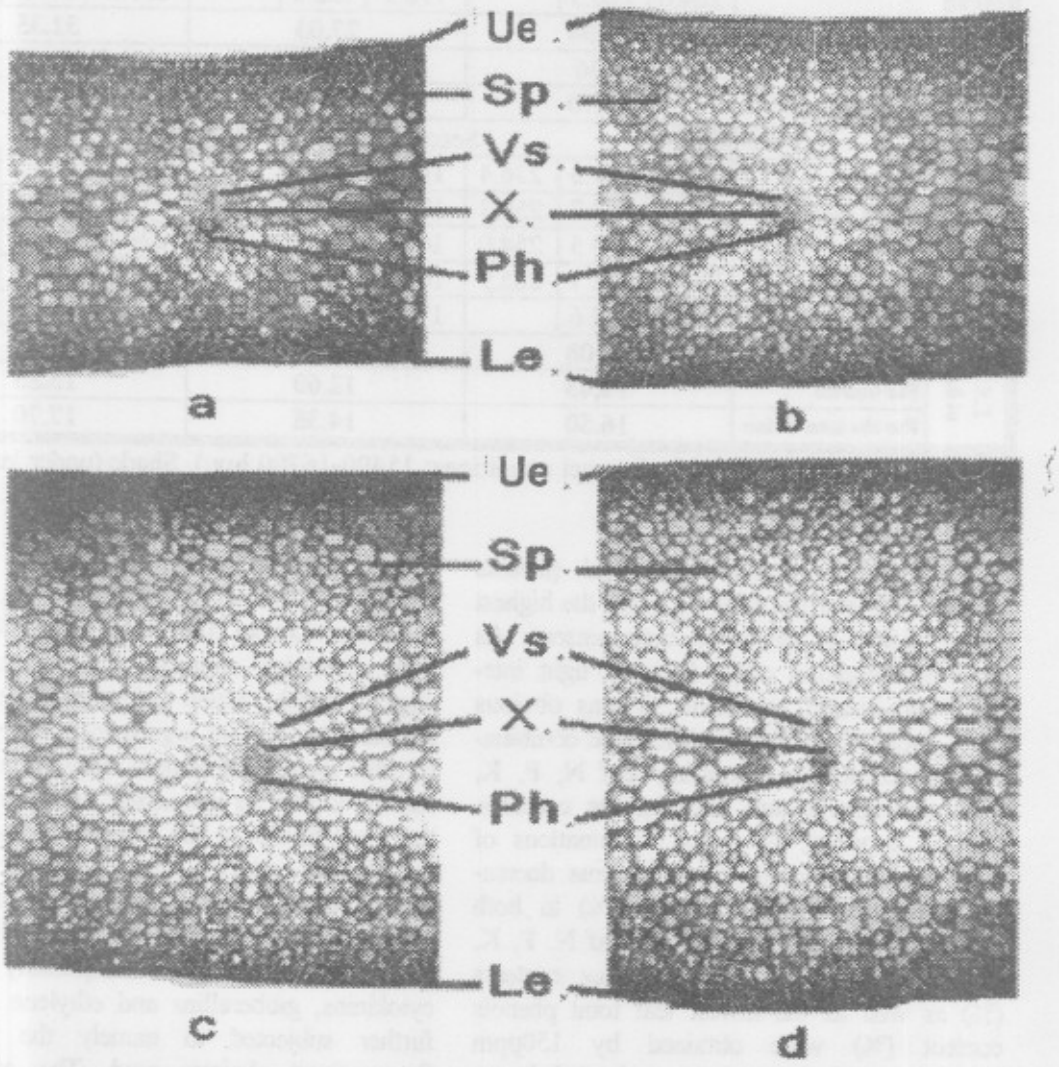


**Fig. (1): Effect of shade condition and kinetin treatments on leaf structure of Clivia plant (50x).**

A - control. b-kinetin at 50ppm. c- kinetin at 100ppm. d- kinetin at 150ppm.
Ue. = Upper epidermis. Sp. = Spongy tissue. Vs. = Vascular bundle.
X. = Xylem tissue. Ph. = Phloem tissue. Le. =Lower epidermis.

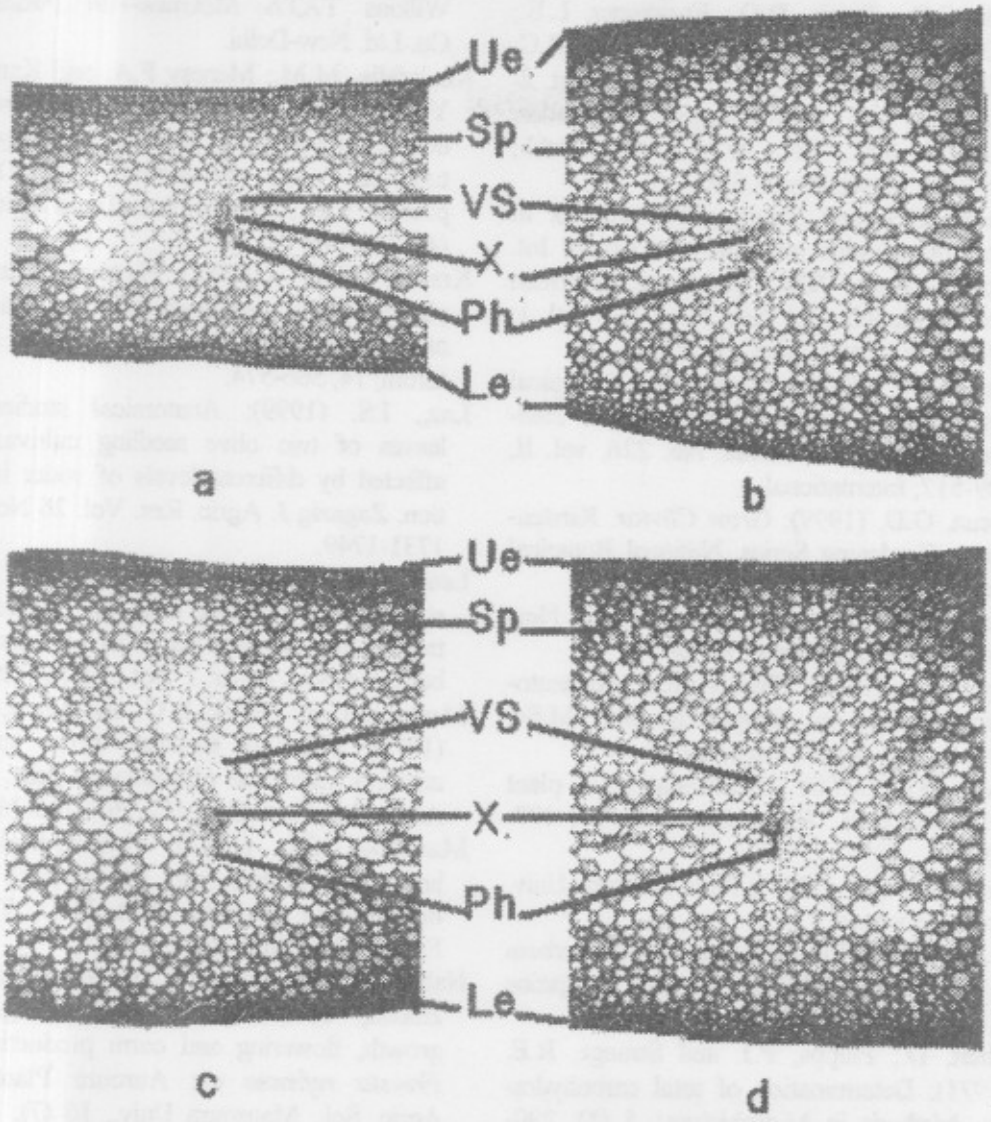


**Fig. (2): Effect of full sun light and kinetin treatments on leaf structure of Clivia plant (50x).**

**a** - control. **b**-kinetin at 50ppm. **c**- kinetin at 100ppm. **d**- kinetin at 150ppm.
**Ue.** = Upper epidermis. **Sp.** = Spongy tissue. **Vs.** = Vascular bundle.
**X.** = Xylem tissue. **Ph.** = Phloem tissue. **Le.** = Lower epidermis.

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## استجابة نباتات الكليفيا للكثافة الضوئية ومعاملات الكينتين

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أجريت تجربتين حقليتين خلال موسمي ٢٠٠٦/٢٠٠٧، ٢٠٠٧/٢٠٠٨ وذلك بمزرعة الزينة بقسم البساتين – كلية الزراعة – جامعة بنها. وذلك لدراسة تأثير كل من الكثافة الضوئية (النمو تحت ظروف الصوبة الخشبية: ٨٦٠٠ – ٩٨٠٠ لوكس والنمو تحت ظروف السيران : ١٥٤٠٠-١٦٧٠٠ لوكس) والكينتين بتركيزات ٥٠، ١٠٠، ١٥٠ جزء في المليون وتفاعلاتهم علي نمو وإزهار والدراسات التشريحية للورقة والمحتوي الكيماوي لنبات الكليفيا.

أوضحت النتائج أن نمو نباتات الكليفيا تحت ظروف الصوبة الخشبية "التظليل" قد أعطت أكبر زيادة في طول النبات وعدد الأوراق والخلف/نبات، عرض وطول والوزن الطازج للورقة وذلك عند المقارنة بالنباتات النامية تحت ظروف السيران " تظليل جزئي ". أدت جميع تركيزات الكينتين وخاصة التركيز العالى (١٥٠ جزء في المليون) إلي زيادة قياسات النمو الخضري. وجد أن جميع التفاعلات بين مستويات الكثافة الضوئية وتركيزات الكينتين قد أدت إلي زيادة قيم قياسات النموالخضري عند المقارنة بالكنترول. وجد أن نمو نباتات الكليفيا تحت ظروف التظليل قد أعطت إزهار مبكر عند المقارنة بالنمو تحت ظروف السيران " تظليل جزئي. أعطي التركيز المتوسط في الكينتين (١٠٠ جزء في المليون)" أسرع إزهار عند المقارنة بباقى التركيزات والكنترول. تم الحصول علي أكبر تبكير في الإزهار عند رش نباتات الكليفيا النامية تحت ظروف التظليل بالكينتين بتركيز ١٠٠ جزء في المليون. وجد أن رش نباتات الكليفيا النامية تحت ظروف التظليل بالكينتين بتركيز ١٥٠ جزء في المليون قد أعطي أكبر القياسات بالنسبة لعدد الأزهار /نبات، عدد الزهيرات/زهرة، طول والوزن الطازج للأزهار.

أظهرت النتائج فى الدراسات التشريحية زيادة قيم قياسات تركيب الورقة فى الظل عنها فى النباتات النامية فى التظليل الجزئى فيما عدا سمك كل من طبقة الكيوتيكل العلوى والسفلى، خلايا البشرة العليا والسفلى، طول الحزمة الوعائية وعدد وسمك نسيج الخشب بها – كما زاد من هذا التأثير معاملة النباتات بالرش الورقى بالكينيتين. أما عن دراسة صفات بشرة الأوراق فقد زاد كل من أبعاد خلايا البشرة (طولها X عرضها) وأيضا أبعاد الثغر (طوله X عرضه) وعدد الثغور المفتوحة فى وحدة مساحة من الورقة (٣٦٠ ميكرون) في حالة النباتات المعرضة للظل بينما قلت أبعاد خلايا البشرة والثغر فى النباتات النامية تحت ظروف السيران " تظليل جزئى كما زاد بها عدد الثغور الكلية والمقفولة فى نفس وحدة مساحة الورقة (٣٦٠ ميكرون) وكانت أفضل القياسات التشريحية هى عند نمو نبات الكليفيا فى الظل والرش الورقى بالكينيتين بمعدل ١٥٠ جزء فى المليون.

كما أمكن الحصول علي أكبر محتوي للأوراق من النيتروجين، البوتاسيوم، الفوسفور، الكلورفيل الكلى والأندولات الكلية وكذلك أقل محتوي للأوراق من الفينولات الكلية عن طريق رش نباتات الكليفيا النامية تحت ظروف التظليل بالكينتين بتركيز ١٥٠ جزء في المليون.