ISSN 1110-0419

Annals Of Agric. Sc., Moshtohor,
Vol. 39(4): 2063-2083, (2001).

RESPONSE OF THE EGYPTIAN COTTON PLANT TO FOLIAR SPRAY WITH SOME MACRO-NUTRIENTS (NPK) AND THE GROWTH REGULATOR PACLOBUTRAZOL (PP_{333})
I- EFFECTS ON VEGETATIVE GROWTH, LEAF ANATOMY AND CHEMICAL COMPONENTS.

BY

El-Desouky, S. A.; Khedr, Z.M.; Wanas, A.L. and Ahmed, H.S.
Dept. of Agric. Botany, Fac. of Agric. Moshtohor, Zagazig Univ., Benha branch

ABSTRACT

Growth of egyptian cotton plants cv. Giza 85 was obviously, affected with foliar application 5 times at 15 days intervals starting 60 days of plant age with N (50 and 250 ppm), P or K (25 and 50 ppm) and paclobutrazol (PP_{333}) (5 and 10 ppm) as well as combination of the low level of both PP_{333} and each of N, P and K. In this respect, significant increase was existed in numbers of both vegetative branches and the formed leaves/plant as well as their dry weights and total leaf area with PP_{333} at 5 or 10 ppm and K at 25 ppm.

Also, anatomically, many features of leaf structure clearly modified with most of the applied treatments. Here, all applied treatments significantly increased thickness of midvein, xylem and phloem tissues, lamina, upper and lower epidermis and palisade and spongy tissues as well. In addition, dimensions of main vascular bundle and number of its xylem vessel rows were also significantly increased with all applied treatments. This increment may be ensure the essentiality of increasing the cross sectional area of phloem for improving both growth and productivity of cotton plants. Furthermore, most applied treatments, obviously, increased leaf crude protein and carbohydrates.

INTRODUCTION

In Egypt, cotton is considered one of the major crops which plays the most important role in the egyptian economy. The cotton cultivated area ranged from 0.9 to 1.2 millions feddan. In the last few years, great attention was paid on the fertility of the cotton cultivated area and series of field trials were conducted to study the effect of different rates of nitrogen, phosphorus, potassium and micronutrients (as soil addition) on cotton yield (lint + seed).

Also, the foliar application with minerals and / or some plant growth regulators by means of spray that offer a method of supplying nutrients to higher plants more rapidly than methods involving root application.

In this respect, despite the drawbacks of supplying nutrients to plants by means of foliar application, the technique has great particle utility under certain conditions. In semi-arid regions, a lack of available water in the topsoil and a corresponding decline in nutrient availability during the growing season are common phenomena, (Marschner, 1995). Even though water may still be available in the subsoil, mineral nutrition became the growth-limiting factor. Under these conditions, soil application of nutrients is much less effective than foliar application. So, the foliar application of mineral nutrients by means of sprays offers a method of supplying nutrients to higher plants more rapidly than methods involving root application. Of different mineral nutrients the early ones on cotton fertilization under local conditions indicated that nitrogen is the limiting element for cotton production in Egypt (Abd El-Hadi *et al.* 1987 and Yassen *et al.* 1990). Here, urea another nitrogen source, can be classified according to its effect on plant metabolism and growth somewhere between nitrate and ammonium (Kirkby and Mengel, 1967).

In addition, the response of cotton to phosphorus and potassium is lower than nitrogen, but it is still profitable to the farmers. Also, the response to phosphorus and potassium is variable and generally not so marked comparing with nitrogen (El-Mowelhi, 1997).

Therefore, in the present study the growth regulator paclobutrazol (PP_{333}) was applied as foliar application separately or combined with nitrogen, phosphorus or potassium. The main effect of paclobutrazol upon plant growth and development takes place through the alteration of the hormone balance. It promotes treated plants to create more cytokinins (Li and Hill, 1989; El-Desouky, 1992; El-Desouky and Abd El-Dayem, 1992a, b and c; Mohamed and El-Desouky, 1992 and Wanas, 1992).

Besides, the egyptian soils, in common with most of the arid and semi-arid regions, are relatively rich in most mineral elements required for plant growth, but deficient in organic matter and some mineral elements by the way of intensive cultivation causing depletion of some mineral nutrients should be compensated by fertilizer application.

Hence, the aim of the present work was to study the effect of foliar spraying with nitrogen, phosphorus and potassium even separately applied or in combination with paclobutrazol on cotton growth. Also, focusing on various anatomical alterations which took place in leaf structure with the assigned treatments to investigate the responsibility of leaf anatomy for determining the growth habit of cotton plants.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Farm of the Faculty of Agriculture at Moshtohor, Zagazig University, Benha Branch during two successive seasons of 1999 and 2000.

Seeds of the egyptian cotton plant (*Gossypium barbadense* Mill.) cultivar Giza 85 were secured from Insitute of Cotton Research, Agricultural Research Center, Ministry of Agriculture, Giza.

Cotton seeds well treated with Rizolex Rt 50 as fungicide were sown on the 15th of March during 1999 season and on the 18th of March during 2000 season at the rate of 10 seeds per hill. The experiment was arranged in a randomized complete block design with four replicates. The experiment unit was 3 x 3.5 meter, including five rows with a distance of 40 cm between hills.

At 37 days from sowing, hills were thinned to one seedling. Then, different agricultural practices including irrigation, weed and pest control were done according to the management system in the Faculty Farm.

Different applied treatments were the following:

1- Spraying with nitrogen N (in the form of urea 46.5 % N w / w as nitrogen source) at the levels of 50 and 250 ppm.
2- Spraying with phosphorus P (in the form of phosphoric acid 80% P a.i. w/v) at the levels of 25 and 50 ppm.
3- Spraying with potassium K (in the form of potassium citrate 48% K a.i. w/w) at the levels of 25 and 50 ppm.
4- Spraying with paclobutrazol (PP_{333} 0.23% a.i.) at the levels of 5 and 10 ppm.
5- Spraying with the combination of PP_{333} at 5 ppm + N at 50 ppm.
6- Spraying with the combination of PP_{333} at 5 ppm + P at 25 ppm.
7- Spraying with the combination of PP_{333} at 5 ppm + K at 25 ppm.
8- Spraying with only distilled water as control treatment.

Cotton plants were foliar sprayed with different assigned treatments five times at 60, 75, 90, 105 and 120 days after sowing, using hand operated compressed air sprayer at the rate of 10 liter/ plot with 1 ml/l of Tween 20 as a wetting and spreading agent.

Sampling and collecting data:

1-Vegetative growth:

Four plants were randomly taken from each plot at 75 days after sowing (after 15 days from the 1st spraying) and at 105 days after sowing, (after 15 days from the 3rd spraying) in both seasons to estimate the following characters:

1-Plant height (cm), 2- Fresh and dry weights of the main stem (g)/ plant. 3- Number of internodes on the main stem/plant. 4- Number of vegetative branches /plant. 5- Fresh and dry weights of the vegetative branches (g)/ plant. 6- Number of leaves/plant. 7- Fresh and dry weights of leaves (g)/ plant. 8- Total leaf area cm^2/plant following the method described by Derieux *et al.* (1973).

II–Anatomical study:

At the age of 105 days after sowing in the second season, specimens (1 cm^2) were taken form the middle part of the 4^{th} apical leaf blade on the main stem including the midvein for the anatomical study.

Specimens were then killed and fixed for at least 48 h in F.A.A. (10 ml formalin, 5ml glacial acetic acid and 85 ml ethyl alcohol 70%), washed in 50% ethyl alcohol, dehydrated in a series of ethyl alcohol (70, 90, 95 and 100%), infiltrated in xylene, then embedded in paraffin wax of a melting point 60-63 C° (Sass, 1951). Specimens were sectioned at 20 µ using a rotary microtome, double stained with fast green and safranin (Johanson, 1940),cleared in xylene and mounted in Canada balsam.

The prepared section were microscopically examined, counts and measurements (µ) were taken using a micrometer eye piece. Averages of readings from 4 slides/ treatment were calculated.

III-Chemical analysis:

Samples of cotton leaves were taken at 105 days after sowing in both seasons to determine some chemical constituents in the dry matter of cotton leaves .

Total nitrogen, phosphorus, potassium and total carbohydrates were determined according to the methods described by Horneck and Miller (1998), Sandell (1950), Horneck and Hanson (1998), and Dubios *et al.*, (1956) respectively. Also, the crude protein was calculated according to the following equation: Crude protein = Total nitrogen x 5.30 (A. O. A. C. , 1990).

IV- Statistical analysis:-

The obtained data in both seasons were subjected to statistical analysis according to Steel and Torrie (1980) using L. S. D. test.

RESULTS AND DISCUSSION

I – Vegetative growth:

1–Main stem:

a)- Plant height:

Table (1) indicate that the treatments of N, K and P at their two applied separately concentrations insignificantly increased the plant height at 75 days after sowing as compared with the untreated plants. Meanwhile, insignificant reduction existed in case of PP_{333} and also the three combination treatments.

On the other hand, at 105 days of plant age the plant height nearly behaved as the same as at 75 days of plant age. Since, its insignificant increase was obtained with the two applied concentrations of N, K and P. Meanwhile, the other applied treatments showed insignificant reduction in this parameter, except that significant reduction existed with PP_{333} at 10 ppm.

Table (1) : Effect of some macro-nutrients (NPK) and paclobutrazol (PP_{333})on some vegetative growth characters of cotton (*Gossypium barbadense* Mill cv. Giza 85) plants at two stages of growth . *

Characters / Treatments	ppm	Main stem: Plant height cm.		No. of internodes/plant		Fresh weight g / plant		Dry weight g/plant		Vegetative branches: Number /plant		F. W. g/plant	D. W. g/plant
Days after sowing		75	105	75	105	75	105	75	105	75	105	105	105
Control	00	34.00	122.30	11.50	21.??	8.03	56.23	1.93	18.08	1.30	1.30	8.08	2.22
Nitrogen	50	35.75	123.00	10.70	21.00	7.93	59.60	1.65	19.26	1.50	2.30	8.50	2.8
	250	37.00	129.38	11.50	21.00	7.45	60.70	1.51	18.60	1.80	2.30	12.70	3.72
Potassium	25	35.25	127.38	12.00	19.30	8.65	59.95	2.06	19.69	1.30	2.80	10.70	3.20
	50	37.50	128.00	12.50	19.00	9.57	61.10	2.10	20.25	1.50	3.00	20.60	8.80
Phosphorus	25	36.35	122.60	10.70	19.50	8.20	62.15	2.03	20.05	1.50	2.00	8.95	2.40
	50	34.50	124.20	11.00	17.00	8.21	59.68	1.97	18.43	1.80	3.00	23.08	7.10
Paclobutrazol	5	33.25	112.30	11.00	20.58	9.30	53.55	2.07	17.70	2.80	3.80	11.70	4.62
	10	31.00	107.00	10.30	19.38	7.93	46.23	1.65	15.05	2.50	3.00	16.30	7.08
PP_{333} 5+ N	50	31.30	116.00	12.30	21.38	8.65	54.23	2.26	17.45	1.80	2.00	16.20	4.93
PP_{333} 5+ K	25	32.50	120.00	11.50	18.50	9.20	58.68	1.96	17.68	1.50	2.00	15.78	5.60
PP_{333} 5+ P	25	32.50	113.60	12.00	17.80	8.93	51.80	2.21	17.90	1.80	2.00	25.90	10.72
L.S.D	0.05	3.68	11.25	1.414	2.0699	1.8204	3.245	0.437	2.9101	0.524	0.664	1.9333	0.6322

* Data represent the mean values of two seasons .

b)-Number of internodes:

As indicated in Table (1) at 75 days after sowing, the applied treatments either insignificantly decreased this number (N at 50 ppm, P at 25 ppm &50 ppm and PP_{333} at 5 &10 ppm) or showed insignificant increase (K at 25 &50 ppm, PP_{333} at 5 ppm + N at 50 ppm and PP_{333} at 5 ppm + P at 25 ppm). The only treatments of N at 250 ppm and the mixture of PP_{333} at 5 ppm + K at 25 ppm had no effect on this parameter.

Meanwhile, at 105 days of plant age this number was significantly decreased with K at 25 and 50 ppm, P at 25 and 50 ppm, PP_{333} at 10 ppm and the two mixtures of PP_{333} at 5 ppm + K or P at 25 ppm. But, insignificant reduction of this number was obtained with the two applied N concentrations and the mixtures of PP_{333} at 5 ppm + N at 50 ppm. The above mentioned results are in harmony with those obtained by El-Shahawy and Abdel-Malik (1999) and Abd El-Dayem and El-Deeb (2000).

c)- Fresh and dry weights:

Data in Table (1) also show that at 75 days after sowing insignificant increase in the fresh or dry weights of main stem was obtained with the applied treatments, except insignificant decrease existed with N at 50 & 250 ppm and PP_{333} at 10 ppm. On the other hand, at 105 days of plant age each of N, K and P with their two applied concentrations as well as the combination of PP_{333} at 5 ppm + K or P at 25 ppm insignificantly increased both parameters. Meanwhile, the other applied treatments insignificantly decreased these two parameters. Exception was the significant reduction that existed in both fresh and dry weights with PP_{333} at 10 ppm. In this respect, other studies have been also reported nearly similar results using either N P K or growth regulators [Hegab *et al.* (1983), Abd-El-Malak *et al.* (1996), Tewolde and Fernandez (1997), Abd El-Dayem and El-Deeb (2000) and Sawan *et al.* (2000)].

2)- Vegetative branches:

a)- Number of branches:

Table (1) shows that, the treatment of PP_{333} at 5 and 10 ppm significantly increased the number of vegetative branches/plant at 75 days after sowing. Meanwhile, insignificant increase existed with the rest of treatments. On the other hand at 105 days of plant age, N and PP_{333} at the two applied concentrations and K 25 ppm exhibited significant increase in this parameter. However, insignificant increase of this number existed with the rest of treatments.

b)- Fresh and dry weights:

As shown in Table (1), at 105 days of plant age significant increase of fresh and dry weights was obtained with different applied treatments except that insignificant increase with N at 50 ppm and P at 25 ppm.

3)- Leaf growth:

a- Number of leaves/plant:

Data in Table (2), clearly indicate that different applied treatments significantly increased leaves number/plant at 75 days of plant age comparing with the control. Exception was insignificant increase existed with the low applied concentration of both N and P (25 ppm).

On the other hand, at 105 days of plant age significant increase in leaves number/plant was the dominant effect of all treatments. Also, it could be noticed that the two applied concentrations of PP_{333} (5&10 ppm) gave the highest leaf number at this stage of growth followed by K with its two applied concentrations (25 & 50 ppm). Besides, lower concentration of each of PP_{333} and K was more effective in this respect.

b- Leaf area (cm^2)/plant:-

As shown in Table (2), either at 75 or 105 days after sowing leaf area/plant nearly behaved as the same as leaves number/plant. Since, significant increase in this parameter was obtained with all applied treatments except insignificant increase with the low concentration of N at 75 days of plant age.

Also, it could be noticed that at 105 days of plant age, increase of leaf area reached its highest value with K at the two applied concentrations. Thereby, leaf area increment could mainly due to the increase in the number of branches/plant accompanying with increase in leaves number. Increases of total leaf area possibly reversed upon photosynthetic efficiency, leading to more photosynthates creation, finally it could be reversed upon vigorous growth of growing plants (Hopkins 1995 and Hendrix, 1995).

c- Fresh and dry weights (g)/plant:-

As shown in Table (2) the treatments of N at 250 ppm, K at 25 and PP_{333} at the two applied concentrations and also the three combinations led to significant increase in both leaves weights/plant at 75 days after sowing. Yet, insignificant increase existed with the rest of treatments.

Meanwhile, at 105 days of plant age both weights were significantly increased with all applied treatments. Also, it could be noticed that the two applied concentrations of PP_{333} gave the highest values of fresh and dry weights/plant, yet, K ranked the second in this respect.

Although the possibility that these mineral nutrients have a direct effect on the biosynthesis of CYT can not be dismissed, it is much more likely that they act indirectly via root growth and the induction of root primordia. The close positive correlation between the number of root primordia and leaf area in tomato plants (Marschner, 1995) is presumably related to CYT production.

Also, there is an impressive example of the key role of CYT in modulating plant growth at high or low supply of mineral nutrients. When plants are grown over a long period with low nutrient supply (3%), their growth rate and

Table (2): Effect of some macro-nutrients (NPK) and paclobutrazol (PP_{333})on leaf growth of of cotton (*Gossypium barbadense* Mill. cv. Giza 85) plants at two growth stages.

Characters / Treatments	ppm	Number of leaves /plant		leaf area cm^2/plant		Leaf fresh weight g/plant		Leaf dry weight g/plant	
		Days after sowing							
		75	105	75	105	75	105	75	105
Control	00	16.25	39.25	742.09	3611.80	22.98	142.87	6.03	38.15
Nitrogen	50	16.75	48.50	771.91	4462.20	24.43	154.80	6.22	43.99
	250	18.50	44.25	845.58	4071.50	26.30	159.85	6.73	46.51
Potassium	25	18.00	53.75	837.16	4734.30	26.53	169.57	6.93	49.86
	50	18.50	47.50	893.67	4601.18	26.96	172.63	6.66	48.15
Phosphorus	25	16.75	44.75	806.26	3996.80	24.81	163.95	6.08	45.13
	50	17.75	46.50	831.75	4176.80	24.87	166.16	6.20	47.16
Paclobutrazol	5	19.00	64.25	856.18	4297.16	23.08	159.62	6.53	49.52
	10	19.75	57.75	852.32	4092.50	26.73	173.99	7.48	52.16
PP_{333}5+ N	50	18.25	47.00	820.44	3864.30	24.99	163.75	6.75	44.69
PP_{333}5+ K	25	17.75	44.50	813.26	4458.50	26.29	164.10	6.78	48.08
PP_{333}5+ P	25	18.00	45.25	839.21	3878.50	25.77	163.54	6.74	45.64
L S D	0.05	0.9138	2.1311	58.76	163.40	1.9288	10.813	0.42	4.0560

* Data represent the mean values of two seasons .

CYT contents are much lower as compared with high nutrient supply (100%). Within two days after transfer from high to low nutrient levels (100- 2%), shoot growth rate and CYT content in shoots and roots declined drastically whereas root growth rate was slightly enhanced. The decline in shoot growth rate could be prevented by amending the low nutrient supply to contain 10^{-8} M benzyladenine (CYT. During these short-term changes in growth rate, mineral nutrient contents in the shoots did not change significantly (Kuiper *et al.*, 1989), confirming that the short-term growth responses were hormonally regulated (Kuiper *et al.*, 1991, Fetene and Beck, 1993 and Fetene *et al.*, 1993). At low nitrogen supply, in *Urtica* the photosynthates were preferentially allocated to the roots whereas at high nitrogen supply, or direct supply of BA to the roots, photosynthates were preferentially allocated to the shoot apex. As an interesting side-effect, long-term supply of different nutrient levels with or without BA not only affected growth rates but also the ATPase activity of root plasma membrane vesicles isolated from these plants (Kuiper *et al.*, 1991).

An example of the effect of nitrogen being now established that plants well supplied with nitrogen, the ABA content of young leaves is somewhat higher than that of fully expanded or old leaves, reflecting phloem transport of ABA from the older (source) to the young (sink) leaves) Zeevaart and Boyer, 1984). Under conditions of nitrogen deficiency, the ABA content increases rapidly in all parts of the shoots. In potato plants this response can be observed within 3 days, and is much more distinct in roots and xylem exudate than in shoots (Krauss, 1978).

II- Effect on leaf anatomy:-

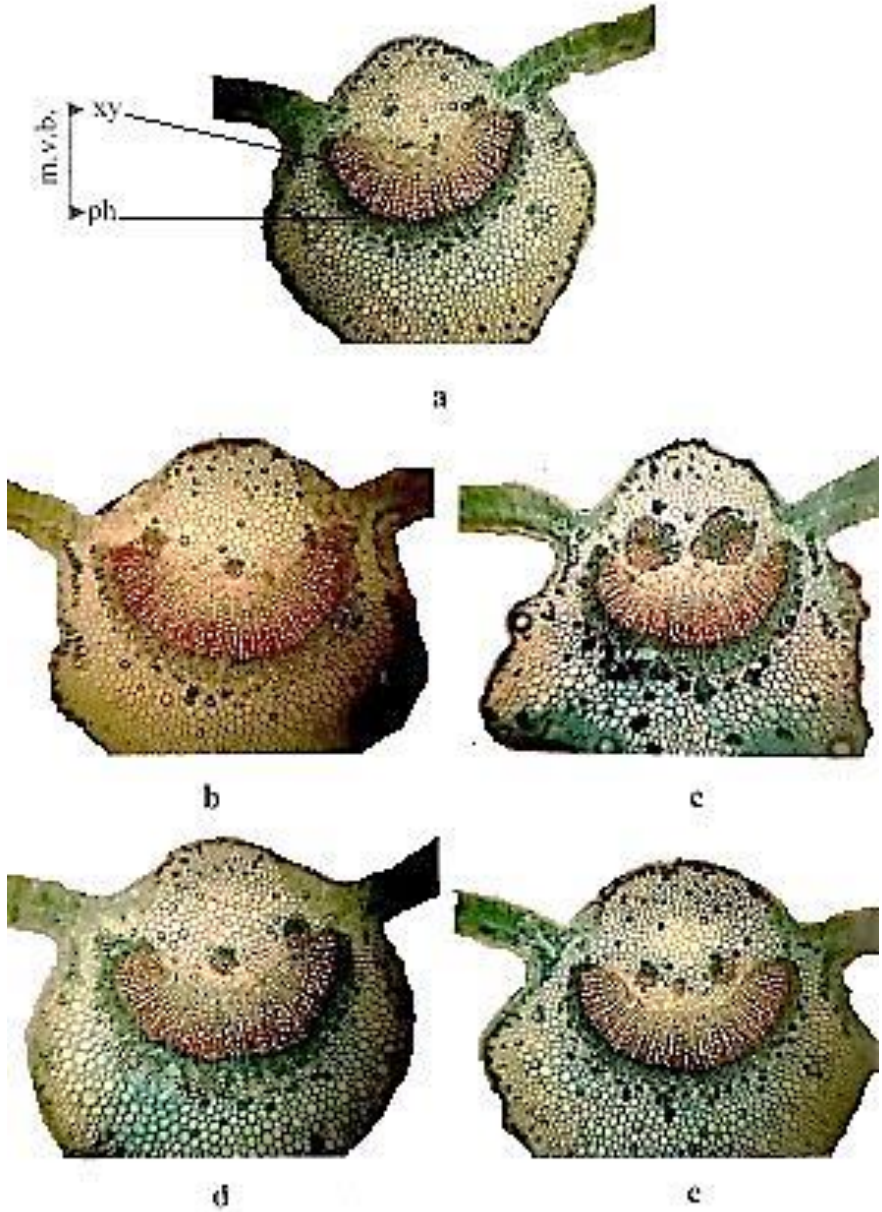
The effects of N, K, P and PP_{333} in the two assigned concentrations of each as well as some of their combinations on the anatomical features of cotton leaf are indicated in tables, (3 &4) and Figures (1&2 a-h).

a- Anatomy of midvein:-

Table, (3) and Figure. (1 a-h) clearly show that all independently applied treatments (N at 50 & 250 ppm, K or P at 25 & 50 ppm and PP_{333} at 5 & 10 ppm) as well as the combination between 5 ppm PP_{333} and 50 ppm N, significantly increased the thickness of midvein to reach its highest value with N at 250 ppm compared with the other two combination treatments (5 ppm PP_{333} + 25 ppm K or P) and control.

As for, the length of main vascular bundle, both N and K with the two applied concentrations for each significantly increased this length. Yet, its insignificant increase occurred with the rest of treatments. The only exception was its insignificant reduction existed with PP_{333} at 5 ppm + N at 50 ppm.

Regarding, the width of main vascular bundle, it was behaved as the same as the thickness of the midvein. Since, its significant increase was obtained with all independent applied treatments, meanwhile its insignificant increase existed in case of other treatments.


m.v.b.
xy
ph
a
b
c
d
e

f

g

h

Fig. (1): Transverse sections through the midvein of the 4^{th} apical leaf of cotton as affected by N P K and PP_{333} (X50)

(a) Untreated plant.
(b) N at 250 ppm
(c) K at 25 ppm.
(d) P at 50 ppm.
(e) PP_{333} at 10 ppm.
(f) PP_{333} at 5 ppm + N at 50 ppm.
(g) PP_{333} at 5 ppm + K at 25 ppm.
(h) PP_{333} at 5 ppm + P at 25 ppm.

Abb.: xy.= xylem tissue, ph. = phloem tissue and m. v. b.= main vascular bundle.

Table (3): Mean counts and measurements of certain histological features (in micron) in transverse section through the midvein of the 4th apical leaf of cotton (*Gossypium barbadese* cv. Giza 85) plants.

Characters / Treatments	ppm	Thickness of midvein	Length of main vascular Bundle	Width of main vascular bundle	Thickness of phloem tissue	Thickness of xylem tissue	No. of xylem vessel rows
Control	00	2243.43	434.77	1169.3	148.37	286.40	36.33
Nitrogen	50	2442.03	510.53	1530.53	196.73	313.80	45.00
	250	2763.77	515.28	1445.68	193.19	342.09	40.33
Potassium	25	2755.33	500.53	1275.60	182.00	318.53	43.00
	50	2380.95	496.30	1241.90	190.33	306.03	38.67
Phosphorus	25	2395.87	453.99	1236.73	147.43	306.56	39.67
	50	2950.67	572.96	1466.94	197.83	375.13	48.00
Paclobutrazol	5	2352.86	453.90	1214.50	155.43	298.46	46.33
	10	2583.20	460.29	1695.40	172.43	287.86	48.67
PP_{333}	5+N 50	2384.63	418.66	1206.97	131.88	286.78	46.33
PP_{333}	5+ K 25	2311.82	474.26	1168.00	166.23	308.03	41.67
PP_{333}	5+ P 25	2297.77	468.80	1178.43	161.50	307.30	38.00
L.S.D	0.05	103.986	44.526	61.511	21.492	28.527	1.8202

With respect to the thickness of phloem tissue as shown in Table, (3) each of N and K with the two applied concentrations as well as P at 50 ppm and PP_{333} at 10 ppm significantly increased this parameter. Meanwhile, its insignificant increase occurred with the rest of treatments.

Concerning, the thickness of xylem tissue its significant increase was obtained with N at 250 ppm, K at 25 ppm and P at 50 ppm. Yet, the other treatments showed insignificant increase in this parameter.

With regard to the number of xylem vessel rows in the main vascular bundle, its significant increase was the dominant result of different treatments except that insignificant increase obtained with PP_{333} at 5 ppm + P at 25 ppm.

b- Anatomy of lamina:

Data in Table, (4) and Figure, (2) clearly indicate that different applied treatments either separately or in combinations caused significant increase in the thickness of lamina. This increase was directly proportional to the applied concentrations of N, P and PP_{333}, yet the reverse was true in case of the two applied concentration of K. Also, it could be noticed that the treatment of N at 250 ppm gave the highest value of lamina thickness followed by PP_{333} at 5 ppm + N at 50 ppm when compared with other treatments. In addition, increase of lamina thickness was accompanying with increase in thickness of its tissue components i.e. thickness of upper and lower epidermis, spongy tissue and palisade tissue. Moreover, it could be noticed that the increase existed in the thickness of palisade tissue was more obvious than that of other lamina tissues.

Table (4): Mean counts and measurements of certain histological features (in micron) in transverse section through the lamina of the 4th apical leaf of cotton (*Gossypium barbadese* cv. Giza 85) plants.

Characters / Treatments ppm	Thickness of Lamina	Thickness of upper epidermis	Thickness of lower epidermis	Thickness of mesophyll tissue	Thickness of palisade tissue	No. of Palisade layers	Thickness of spongy tissue	No. of Spongy Layers
Control 00	265.56	23.93	22.53	218.10	106.10	1.0	112.00	4.00
Nitrogen 50	325.25	26.36	24.03	274.86	131.96	1.0	142.90	4.00
250	345.21	28.96	25.43	290.82	138.36	1.0	152.46	4.00
Potassium 25	324.89	27.66	24.40	272.83	136.43	1.0	136.40	4.00
50	293.79	26.30	24.30	243.19	122.03	1.0	121.16	4.00
Phosphorus 25	312.82	25.06	24.23	264.53	127.40	1.0	137.13	4.00
50	323.98	25.23	24.66	274.09	129.76	1.0	144.33	4.00
Paclobutrazol 5	296.35	27.56	25.63	243.16	180.83	1.0	122.33	4.00
10	304.43	25.13	24.80	254.50	138.10	1.0	116.40	4.00
PP_{333} 5+N 50	328.59	27.53	24.66	277.43	139.20	1.0	138.23	4.00
PP_{333} 5+K 25	317.75	27.23	25.63	268.89	128.83	1.0	140.06	4.66
PP_{333} 5+P 25	300.19	25.63	23.86	250.70	119.20	1.0	131.50	4.33
L.S.D 0.05	26.6371	1.3105	1.3144	23.9308	9.7158	0.00	3.4475	0.00

To our knowledge, is that only Gausman *et al.*, (1980) investigated the mepiquat chloride effects on cotton leaf anatomy. When leaves from field grown cotton cv. Tamcot SP-37 were treated with 75g a.i mepiquat chloride / ha, epidermal thickness and the mesophyll cell surface area leaf surface area ratio were unaffected by this treatment, but palisade cells became thinner and longer with fewer mesophyll air spaces. These air spaces tended to be larger than in the untreated control.

III- Chemical analysis:

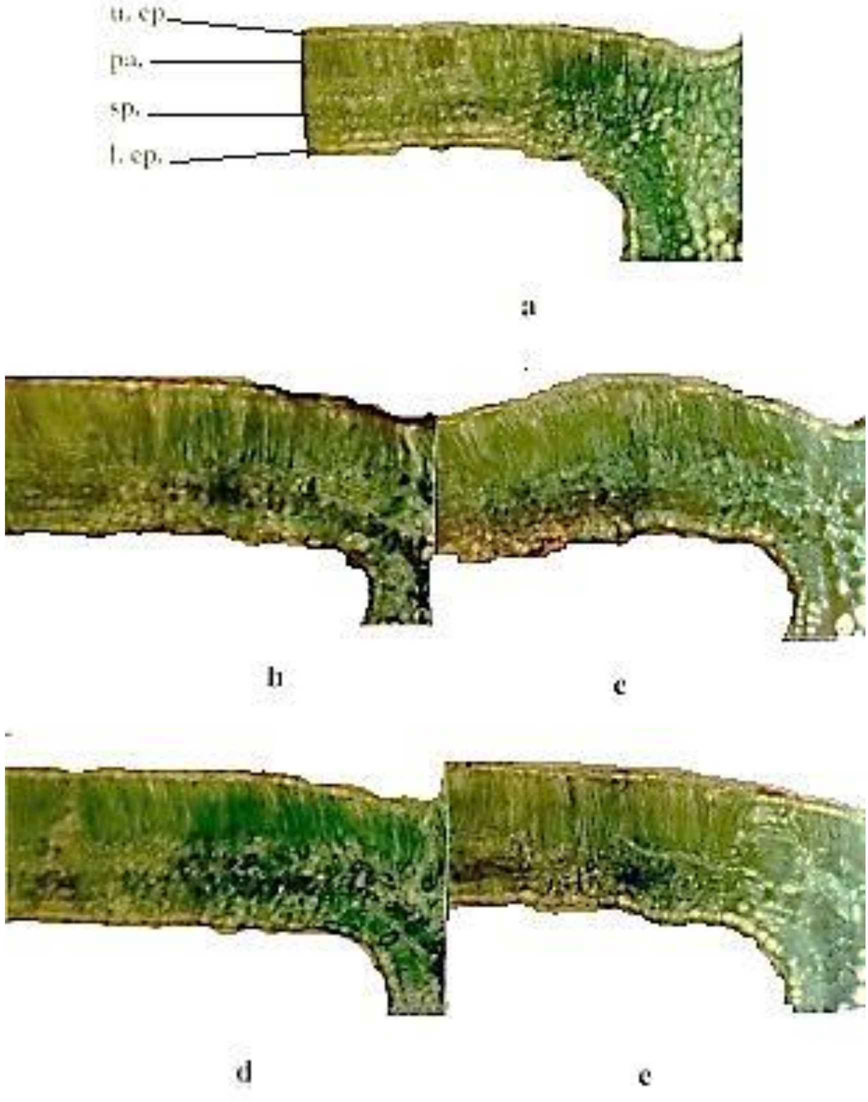
a)- NPK:

1) Nitrogen:

Data in Table (5) clearly indicate that different applied treatments increased N content in leaves of cotton plants at 105 days of plant age. Also, it could be noticed that the two N applied concentrations gave the highest Nitrogen content in leaves at this stage of growth. Meanwhile, PP_{333} ranked the second in this respect followed by the combination treatments. Yet, P and K ranked the last regarding their effect upon N content.

2) phosphorus

Data in Table (5) clearly indicate that the two applied concentrations of N and K as well as pp_{333} at 5 ppm + N at 50 ppm decreased the P content in cotton leaves at 105 days after sowing. The highest reduction in this content existed with the treatment of N at 50 ppm followed by N at 50 ppm. On the contrary the two applied concentrations of P and pp_{333} and also PP_{333} at 5 ppm + P at 25 ppm increased the P content in cotton leaves. Meanwhile, the treatments of


u. ep.
pa.
sp.
l. ep.
a
b
c
d
e

f

g h

Fig. (2): Transverse sections through the lamina of the 4[th] apical leaf of cotton as affected by N P K and PP_{333} (X 200).

(a) Untreated plant.
(b) N at 250 ppm.
(c) K at 25 ppm.
(d) P at 50 ppm.
(e) PP_{333} at 10 ppm.
(f) PP_{333} at 5 ppm + N at 50 ppm.
(g) PP_{333} at 5 ppm + K at 25 ppm.
(h) PP_{333} at 5 ppm + P at 25 ppm.

Abb.: u.ep.= upper epidermis, l.ep. = lower epidermis, pa.= palisade tissue and sp. = spongy tissue.

PP_{333} at 5ppm and PP_{333} at 5 ppm + K at 25 ppm had no effect upon this content in leaves at 105 days after sowing.

3) Potassium

As shown in Table (5) the K content in cotton leaves at 105 days after sowing was increased with all spraying treatments. The highest increase was obtained with P at 50 ppm followed by N at 50 ppm. Meanwhile, the lowest increase was obtained with P at 25 ppm. In this respect, Oosterhuis *et al*., (1990) reported that N treatment led to increase K concentration in cotton leaves.

b) crude protein :

Data of calculated protein content indicate that different applied treatments increased crude protein content in cotton leaves at 105 days of plant age when compared with those of the control. Also, it could be noticed that the two N applied concentrations gave maximum increase of this content. Meanwhile, PP_{333} at 5 ppm + N at 50 ppm showed its lowest content compared with other treatments.

Table (5): Effect of some macro-nutrients (NPK) and paclobutrazol (PP_{333}) on some minerals (NPK), crude protein, and carbohydrate contents in leaves of cotton (*Gossypium barbadense* cv. Giza 85) plants at 105 days after sowing.*

Characters / Treatments ppm	N	P	K	Crude protein	Total Carbohy-drates
	%				
Control 00	3.30	0.28	2.23	20.63	29.24
Nitrogen 50	3.74	0.26	3.00	23.38	23.01
250	3.92	0.25	3.10	24.50	19.68
Potassium 25	3.54	0.27	2.70	22.13	30.80
50	3.50	0.26	2.92	21.88	33.35
Phosphorus 25	3.48	0.30	2.65	21.75	34.23
50	3.58	0.32	3.13	22.38	35.93
Paclobutrazol 5	3.70	0.28	2.95	23.13	29.71
10	3.52	0.30	3.00	22.00	34.09
PP_{333} 5+N 50	3.36	0.26	2.92	21.00	33.48
PP_{333} 5+ K 25	3.72	0.28	3.08	23.25	38.44
PP_{333} 5+ P 25	3.66	0.33	2.95	22.88	37.08

*Data represent the mean values of 1996 and 1997 seasons .

c) Total carbohydrates:-

The total carbohydrates content in cotton leaves at 105 days of plant age was increased with the two applied concentrations of each of K, P and PP_{333} as well as the three combination treatments. Here, the treatments of PP_{333} at 5 ppm + k at 25 ppm gave the highest content. On the other hand, reduction in this content was obtained with the two N applied concentrations.

In this respect, Abd El-Dayem and El-Deeb (2000) reported that PP_{333} increased N, P, K and total carbohydrates content in cotton leaves.

Of the mineral nutrients, nitrogen has the most prominent influence on both root growth and the production and export of cytokinin to the shoots. Because CYT is exported mainly in the xylem, collecting xylem exudate is a simple method of obtaining information on the nitrogen effect. When the nitrogen supply is continuous, CYT export increases with plant age, whereas when the supply is interrupted, the roots respond rapidly by a drastic decrease in CYT export. After the nitrogen supply is restored, CYT export is rapidly enhanced (Forsyth and Van Staden, 1981).

The synthesis and export of CYT are also affected by phosphorus and potassium supply, although this effect is somewhat less prominent than in the case of nitrogen.

In crop species such as tomato and barley, short-term response to withdrawal of nitrogen supply is an immediate reduction of leaf elongation rate. Net photosynthesis, however, is not affected so that an accumulation of sugars occurs in these plants (Chapin *et al.*, 1988). This short-term response in leaf elongation rate was associated with a sharp increase in ABA content in the shoots. Only gradually did rates of photosynthesis as a response of the stomata closing to the elevated ABA contents, and also probably to the declining CYT contents (Chapin *et al.*, 1988).

In tall fescue (*Festuca arundinacea*) low nitrogen supply decreases the number of epidermal cells as well as their elongation rate, and the duration of epidermal cell elongation is about 20 h shorter as compared with plants with high nitrogen supply (McAdams *et al.*, 1989).

Finally, regarding different alterations in leaf tissues created with different applied treatments it could be concluded that:

a) Firstly, an increase in the thickness of palisade tissue might correlate with increment of chloroplasts in this tissue. That could be reversed upon the efficiency of photosynthesis process. Hence, more favorable conditions being existed for more photosynthates formation.
b) Secondly, an increase in thickness of either xylem or phloem tissue ensures improvement of translocation into and outside leaves for inorganic solutes and organic synthates, respectively. This conclusion also ensures the essentiality of increasing the cross sectional area of phloem (Canny, 1973; Evans and Rawsen, 1970 and Mitra *et al.*, 1993). Since, it considered the main factor for determining both growth and the final yield of any growing plant.

Therefore, vigorous growth that obtained with the assigned treatments due to alterations in hormone profile, leaf characters as well as in leaf anatomy would be reversed upon reproductive growth of cotton plants. Hence, practically, the applied treatments especially N at 250 ppm, K at 25 ppm, P at 50 ppm, PP_{333}

at 10 ppm and the combination between 5 ppm PP_{333} and 25 ppm K or P being of economic importance.

REFERENCES

A.O.A.C. (1990): Official Methods of Analysis, 10[th] Ed., Association of official Analytical Chemists, Inc USA.

Abd El-Hadi, A.H.; Moustafa, A-A. and Mohamed, Y.H. (.1987): Effect of N, p & K on cotton yield production in egyptian soils. First Conf. of Fertilizers. "Available and Needs. April 13a 1 6 Cairo, Egypt.

Abd El-Dayem, H.M.M. and El-Deeb, A.E.A. (2000):Effect of some growth regulators on growth, yield components and some chemical constituents of cotton plants. Ann. Agric. Sci., Moshtohor, 38(2): 907-925.

Abd El-Malak, K.K.I.; Makram, E.A. and El-Razaz, M.M. (1996): Effect of hill spacing and nitrogen levels in relation to planting dates on growth and yield of Giza 83 cotton cultivar. Assiut Journal of Agricultural Sciences 27 17; 168-155, 1: ref.

Canny, M.K. (1973): Phloem translocation. London and New York: Cambridge University Press.

Chapin, F.S. III, Walter, C.H.S. and Clarkson, D.T. (1988):Growth response of barley and tomato to nitrogen stress and its control by abscisic acid, water relations and photosynthesis. Planta 173, 352-366.

Deriaux, M.; Kerrest, R. and Montalon, Y. (1973): Etude de la sulface foliare et de l'activite photosynthetique chez quiques hybrides de mais. Ann. Amelior plantes, 23: 95-107.

Dubios, K.A.; Gilles, J.K.; Ramilton, R. P.A. and Smith, F. (1956): Colorimetric method for determination sugars and related substances. Anal. Chem. 28, 350-356.

El-Desouky, S.A. (1992): Response of tomato plants) Lycopersicon esculentum Mill) to some growth regulators. Egypt. J. Appl. Sci., 7 (3): 181-199.

El-Desouky, S.A. and Abd El-Dayem, H.M.M. (1992a): Response of sesame plants (Sesamum indicum L.) to the foliar application of paclobutrazol (PP_{333}) and Ethrel (CEPA). Egypt. J. Appl. Sci, 7 (12): 102-119.

El-Desouky, S.A. and Abd El-Dayem, H.M.M. (1992b):Response of rapeseed plants (Brassica napus L.) to floiar spray with some growth regulators I- Growth, seed yield and seed contents. Egypt. J. Appl. Sci., 7 (12): 479-496.

El-Desouky, S.A. and Abd El-Dayem, H.M.M. (1992c) : Response of rapeseed plants (Brassica napus L.) to foliar spray with some growth regulators II- Endogenous phytohormones Photosynthetic pigments, carbohydrates and NPK contents during the vegetative stage. Egypt J. Appl. Sci, 7 (12) 1992.

El-Mowelhi, N. (1997): Cotton fertilization in Egypt. Proc. FAO-IRCRNC: joint meeting of the working groups 4 & 3 (cotton nutrition & growth regulators); Cairo-Egypt, pp. 21-23.

El-Shahawy, M.I.M. and Abd El-Malik, R.R. (1999): Response of Giza 87 cotton cultivar (Gossypium barbadense Mill.) to irrigation intervals and nitrogen fertilization levels. Egyptian Journal of Agricultural Research 77: 2, 841-856; 30 ref.

Evans, T. and Rawsen, H.M. (1970): Photosynthesis and respiration by the flag leaf and component of the ear during grain development. Aust. J. of Biol. Sc., 23: 245-254.

Fetene, M. and Beck, E. (1993): Reversal of the direction of photosynthate allocation in Urtica dioica L. plants by increasing cytokinin import into the shoot. Bot Acta 106, 235-240.

Fetene, M. Moller, I. and Beck, E. (1993): The effect of nitrogen supply to Urtica dioica L. plants on the distribution of assimilate between shoot and roots. Bot. Acta 106, 228-234.

Forsyth, C. and Van Staden, J. (1981): The effect of root decapitation on lateral root formation and cytokinin production in Pisum sativum. Physiol. Plant. 51, 375-379.

Gausman, H.W.; Stuhenow, J.; Rittig, F.R.; Escobar, D.E.; Garza, M.V and Abdel-Rahman, M. (1980): Mepiquat chloride effects on cotton leaf anatomy. Proceedings of the plant growth regulator working group. 1, 8-14; 17 ref.

Hegab, A.A.T.; Mahgoub, M.A.; Abdellah, M.E. and Syiam, M.M. (1983): Effect of macro and micro nutrients on growth, yield and quality of fiber as well as yard properties of Egyptian cotton (Gossypium barbadense Mill.) in two locations. Zeitschrift für Acker und pflanzenbau 152:2, 135-145; 13 ref.

Hendrix, J. E. (1995): Assimilate transport and partitioning. In Handbook of plant crop physiology (M. Pessaraklied). Marcel Dekker, Inc. New York, Basel, Hong Kong. PP: 357-385.

Hopkins, W. G. (1995): Carbon assimilation and productivity. In: Introduction to plant physiology. John wiley & sons Inc ed PP: 251-261.

Horneck, D.A. and Hansen, D. (1998): Determination of potassium and sodium by Flame Emission Spectrophotometry In Handbook of Reference Methods for Plant Analysis. Kalara, Y.D.(ed): 153-155.

Horneck, D.A. and Miller, R.O. (1998): Determination of total nitrogen in plant tissue. In Handbook of Reference Methods for Plant Analysis. Kalara, Y.D. (ed): 75-83.

Johanson, D.A. (1940): Plant microtechnique. New York and London Mc Grow-Hill Book Co., Inc. pp. 27-154.

Kirkby, E.A. and Mengel, K. (1967): Ionic balance in different tissues of the tomato plant in relation to nitrate, urea, or ammonium nutrition. Plant Physiol. 42, 6-14.

Krauss, A. (1978): Tuberization and abscisic acid content in solanum tuberosum as affected by nitrogen nutrition. Potato Res. 21, 183-193.

Kuiper, D.; Kuiper, P.J.C.; Lambers, H.; Schuit, J. and Staal, M. (1989): Cytokinin concentration in relation to mineral nutrition and benzyladenine treatment in plantago major spp. pleiosperma. Physiol. Plant. 75, 511-517.

Kuiper, D.; Schuit, J. and Kuiper, P.J.C. (1991): Effect of internal and external cytokinin concentrations on root growth and shoot to root ratio of plantago major spp. plejosperma at different nutrient concentrations. Plant Soil 111, 231-236.

Li, Q.F and. Hill, M.J (1989): Effect of the growth regulator paclobutrazol on plant growth and seed production of Lotus corniculatus L. New Zealand J. of Agric. Res., 32(4): 507-514.

Marschner, H. (1995): Mineral nutrition and yield response. In: mineral nutrition of higher plants 2nd ed., Academic press, pp. 184-200.

McAdams, J.W.; Volence, J.J. and Nelson, C.J. (1989): Effect of N on mesophyll cell division and epidermal cell elongation. In tall fescue leaf blades. Plant Physiol., (89): 549-556.

Mitra, S.; Bhardwaj, S.N. and Srivastava, G.C. (1993): Assimilate partitioning within leaves of small grain cereals. In photosynthesis. Photoreaction to plant productivity. PP: 351-360, (eds) Y.P., Abrali P., Mohanty and Cov: ndjee. Oxford & IBH publishes Co. PVILTD, New Delhi Bombay Calcuta.

Mohamed, S.M. and El-Desouky, S.A. (1992): Response of Chlorophytum comosum and Peperomia to some growth regulators Egypt. J. Appl. Sci., 7 (6):625-645.

Oosterhuis, D.M.; Wullschleger, S.D.; Maples, R.L and Miley, W.N. (1990): Foliar feeding of potassium nitrate in cotton. Better Crops with Plant Food. 74: 3- 8-9.

Sandell, R. (1950): Colorimetric determination of traces of metal 2nd Ed. Interscience Publishers Inc. New York.

Sass, J.E. (1951): Botanical Microtechnique. Iowa state college Press, Ames, Iowa, pp. 228.

Sawan, Z.M.; Mohamed, A.A.; Sakr, R.A. and Tarrad, A.M. (2000): Effect of kinetin concentration and methods of application on seed germination, yield components, yield and fiber properties of the egyptian cotton (Gossypium barbadense Mill.). Environmental and Experimental Botany. 44: 1, 59-68; 34 ref.

Steel, R.G.D. and Torrie, J.H. (1980):Principles and Producers of statics Mc Graw-Hill Book Company Inc, New York, Tornato, London.

Tewolde, H. and Fernandez, C.J. (1997): Vegetative and reproductive dry weight inhibition in nitrogen and phosphorus deficient Pima cotton. Journal of Plant Nutrition, 20: 2-3, 219-232; 14 ref.

Wasas, A.L. (1992): Botanical studies on some members of Fabaceae family. M. Sc. Thesis, Fac. of Agric, Moshtohor, Zagazig Univ.

Yassen A.I.H.; Negm, A.Y., and Hosny, A.A. (1990): Effect of increasing population and nitrogen on growth yield of Giza 76 cotton variety. Annals of Agric. Sci., Fac Agric., Ain Shams Univ., Cairo Egypt. 35 (2) 1 761- 760.

Zeevaart, J.A.D. and Boyer, G.L. (1984): Accumulation and transport of abscisic acid and its metabolites in Ricinus and Xanthium. Plant physiol. 74. 934-939.

استجابة نبات القطن المصري للرش الورقي بالنيتروجين والفسفور والبوتاسيوم وكذلك منظم النمو الباكلوبيوترازول
١- التأثير على النمو الخضري وتشريح الورقة والمكونات الكيميائية.

سعيد علي الشرقي ، زكريا محمد خضر ، أحمد لطفي ونس و حامد سيد أحمد.
قسم النبات الزراعي – كلية الزراعة بمشتهر – جامعة الزقازيق/فرع بنها

تأثر بوضوح نمو نباتات القطن برشها على المجموع الخضري خمسة مرات متتالية وبفاصل ١٥ يوما بين الرشات ابتداء من عمر ٦٠ يوما من عمر النبات ..وذلك بالنيتروجين بتركيزي ٢٥٠،٥٠ جزء في المليون والفسفور والبوتاسيوم بتركيزي ٥٠،٢٥ جزء في المليون لكل منهما، والباكلوبيوترازول بتركيزي ١٠،٥ جزء في المليون، وكذلك الرش بمخاليط التركيز الأقل من الباكلوبيوترازول مع التركيز الأقل من النيتروجين والبوتاسيوم والفسفور.

ومن أهم النتائج في هذه الدراسة... هي تلك الزيادة المعنوية في عدد كل من الأفرع الخضرية وعدد الأوراق /نبات وكذلك أوزانها الجافة والمساحة الكلية للأوراق خاصة مع معاملات الباكلوبيوترازول بكلا تركيزيه والبوتاسيوم بتركيزه المنخفض.

أيضا من الناحية التشريحية... فقد تأثرت معنويا كثير من الصفات التركيبية للأوراق مع كل المعاملات؛ المستخدمة حيث حدثت زيادة معنوية مع كل المعاملات في سمك العرق الوسطي، نسيجي الخشب واللحاء ، النصل، البشرة العليا والسفلى وكذلك النسيج العمادي والإسفنجي بالإضافة إلى ذلك فإن أبعاد الحزمة الوعائية الرئيسية بالعرق الوسطى وكذلك عدد صفوف أوعية الخشب بها قد زادت زيادة معنوية بالمعاملات جميعها.

علاوة على ذلك... فإن التغيرات التشريحية في هذه الدراسة والتي وجدت من خلال دراسة التركيب الداخلي للأوراق مع جميع المعاملات تؤكد أهمية زيادة مساحة المقطع العرضي لنسيج اللحاء من حيث تحسين كل من صفات النمو والمحصول لنبات القطن.
والأكثر من ذلك... أن معظم المعاملات أدت إلى زيادة واضحة في تلك المكونات الحيوية التي تم تقديرها بالأوراق مثل البروتين والكربوهيدرات وكذلك محتوى الأوراق من النيتروجين والفسفور والبوتاسيوم .