RESULTS AND DISCUSSION

The following results on growth, yield, yield components, fiber properties and chemical analysis of cotton plants Giza 80 cultivar. Under the three experimental factors i.e. planting dates, potassium and boron fertilizer in the two growing seasons 2005 and 2006 will be discussed under the following headlines,

I. Growth characters

A. Effect of planting dates on:

1. *Plant height (cm)*

Results in Table (1) show that plant height was insignificantly affected by planting date in both seasons. Average plant height 15 March and 15 April were 104.79 and 110.49 cm in the first season, respectively. Corresponding values for the second season were 113.22 and 113.59 cm,. These results are in a good accordance with those obtained by **Abou El-Nour *et al.* (2000)** who found that late planting date increased plant height.

2. *Position of first fruiting node*

Position of first fruiting node was not affected by planting dates in both growing seasons (Table, 1). Average position of first fruiting node was 8.42 and 9.05 in the first season and 8.67 and 9.84 in the second season, respectively. It is worthy to notice that the earlier planting date slightly improved this parameter but the difference did not reach the significant value.

Table (1):Effect of planting dates on growth characters of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Planting date (A)	Plant height (cm)	Position of first fruiting node	No. of fruiting branches / plant	Leaf area / plant (cm)	Leaf area index
2005 season					
15 March	104.79	8.42	15.12	1572.6	1.31
15 April	110.49	9.05	14.69	1868.4	1.56
L.S.D. at 0.05	**N.S.**	**N.S.**	**N.S.**	**95.2**	**0.07**
2006 season					
15 March	113.22	8.67	15.09	1578.0	1.31
15 April	113.59	9.84	15.02	1824.0	1.52
L.S.D. at 0.05	**N.S.**	**N.S.**	**N.S.**	**72.6**	**0.07**

3. *Number of fruiting branches / plant*

Results in Table (1) show that number of fruiting branches / plant was not significant by affected by sowing dates in both seasons. The average of fruiting branches / plant were 15.12 and 14.69 in the first season, respectively. The values for the second season were 15.09 and 15.02, in that order, **Ali *et al* (1996) and Abo El-Nour *et al* (2000)** indicating that early planting on 15th March increased the number of fruiting branches. **Buttor *et al* (2004), Kumbhar *et al* (2004) and Killi (2005)** found that delaying sowing date decreased number of fruiting branches / plant

4. *Leaf area / plant (cm^2)*

The results in the same table clearly show that planting date had significant effects on leaf area / plant (cm^2) in both seasons. The highest values of leaf area / plant (1868.4 and 1824.0 cm^2) were obtained when planting date was on 15 April, while the lowest values of leaf area / plant (1572.6 and 1578.0 cm^2) were recorded when planting date was on 15 March in 2005 and 2006 seasons, respectively. The enhancement of leaf area caused by late planting may be attributed to elevated temperature that increased leaf area according to the explanation given by (**Kassem, 1999**).

5. *Leaf area index*

The results in Table (1) indicate that leaf area index was significantly affected by planting dates in both seasons. The highest values of leaf area index (1.56 and 1.52) were obtained by late planting date of 15 April. However, the lowest value (1.31) was obtained by earlier planting date of 15 March in 2005

and 2006 seasons, Appearntly. Leaf expansion enhanced by elevated temperature increased leaf area index in favour of late planting date according to **Kassem (1999) and Butter *et al* (2004)**.

A major concern of cotton production is the appropriate conditions which ensure a crop of both high yield and of high quality. Therefore, it is very important to choose the suitable atmosphere around cotton plants to enhance growth characters and obtain healthy plants with high productivity. It is obvious from data obtained to emphasis that the planting date be suitable for improving growth characters of plants (i.e. plant height, position of first fruiting node, no. of fruiting branches / plant, leaf area / plant and leaf area index).

B. Effect of potassium fertilization on:

1. *Plant height (cm)*

The results in Table (2) clearly show that plant height was significantly affected by potassium fertilizer only. Foliar spraying potassium at the rate of 2.4 kg K_2O / fed as twice at squaring and flowering stage produced the tallest plants (110.20 cm). While, 24 kg K_2O / fed as soil application after thinning resulted the shortest plants (105.5 cm). On the other hand, plant height was not affected by potassium treatments in the second season. The insignificant effect of potassium on plant height was recorded by many authors such as **Mercado and Cabangbag (1986) and Abou El-Nour *et al.* (2000)**. These results my be due to that the amount of potassium in the soil was enough for cotton plant need.

Table (2): Effect of potassium fertilization on growth characters of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Potassium fertilization (K_2O/fed) (B)	Plant height (cm)	Position of first fruiting node	No. of fruiting branches / plant	Leaf area / plant (cm)	Leaf area index
2005 season					
24 kg after thinning.	105.54	8.75	14.48	1810.1	1.51
24 Kg after thinning + 2.4 kg spray at flowering stage.	107.20	8.62	14.75	1781.2	1.49
2.4 kg spray at squaring stage + 2.4 kg spray at flowering stage.	110.20	8.83	15.49	1570.2	1.30
L.S.D. at 0.05	**3.43**	**N.S.**	**0.31**	**114.90**	**0.09**
2006 season					
24 kg after thinning.	111.83	9.31	14.81	1776.0	1.48
24 Kg after thinning + 2.4 kg spray at flowering stage.	113.91	9.16	15.14	1745.0	1.45
2.4 kg spray at squaring stage + 2.4 kg spray at flowering stage.	114.49	9.29	15.16	1583.0	1.32
L.S.D. at 0.05	**N.S.**	**N.S.**	**N.S.**	**80.2**	**0.07**

2. *Position of first fruiting node*

The results in Table (2) show insignificant effect on position of first fruiting node by potassium fertilizer in the two growing seasons. The lowest fruiting node (8.62 and 9.16) was obtained by 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage in 2005 and 2006 seasons, respectively. On the other hand, **Abou- Zeid *et al* (1997)** and **Abou El-Nour *et al.* (2000)** reported a significant decrease by potassium fertilizer for position of first fruiting branch.

3. *Number of fruiting branches / plant*

The results in Table (2) clearly show that number of fruiting branches / plant was significantly affected by potassium fertilizer in the first season only. Added potassium as 2.4 kg K_2O / fed spraying twice at squaring and flowering stages gave the highest number of fruiting branches / plant (15.49), while, 24 kg K_2O / fed as soil application after thinning yielded the lowest number of fruiting branches / plant (14.48). On the other hand, number of fruiting branches / plant was not significantly affected by potassium treatments in the second season. Similar results were obtained by **Abou-Zeid *et al.* (1997), Abou El-Nour *et al.* (2000)** and **Mohsin *et al.* (2004).**

4. *Leaf area / plant (cm^2)*

Concerning the effect of potassium fertilizer, Table (2) reveal that potassium treatments gave a significant increase of leaf area / plant in both seasons. The highest values of leaf area / plant (1810.1 and 1776.0 cm^2) were obtained from applying 24 kg K_2O / fed as soil application after thinning, while the lowest values (1570.2 and 1583.0 cm^2) were recorded for applying 2.4

kg K_2O / fed foliars praying twice at squaring and flowering stages in 2005 and 2006 seasons, respectively.

5. *Leaf area index*

Results in Table (2) indicate that leaf area index was significantly affected by potassium treatments in both seasons. The highest values of leaf area index (1.51 and 1.48) were obtained from applying 24 kg K_2O / fed as soil application after thinning, while the lowest values of leaf area index (1.30 and 1.32) were recorded for applying 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages in 2005 and 2006 seasons, respectively.

Evidently, the application of potassium fertilizer plays an important role in the translocation of photosynthates from source sites and has favorable effects on growth substances and development processes. Meanwhile, it is true that crop of cotton will fall short of expressing its genetic potential when any of the essential elements is in short supply photosynthesis.

Mullins *et al.* (1991) and **Cassman *et al.* (1992)**, reported that potassium was quite important for enhancing the activity of photosynthesis in different ways, regardless of leaves number and leaf area per / plant. **Cokmak *et al.* (1994)** found notable improvements in cotton growth by application of potassium fertilizer. Results will be more conversion of light energy in which the plants were received chemical energy expressed as dry matter production. Moreover, **Abou El-Nour *et al.* (2000) and Ghourab *et al.* (2000),** mentioned that potassium directly influence the growth and development processes.

C. Effect of boron fertilization on:

1. *Plant height (cm)*

Results recorded in Table (3) show that plant height was significantly affected by application of boron fertilizer in both growing seasons. The averages plant height due to added 0, 700 and 1400 gm / fed boric acid were 108.12, 112.04 and 102.07 cm in the first season, respectively. The corresponding values for the second season were 112.54, 116.33 and 11.35 cm. It is obvious that adding 700 gm / fed boric acid increased cotton plant height as compared to without boron and then decreased as boron increased to 1400 gm boric acid / fed. The decreasing of plant height by increasing boron is mostly explained by the toxic effect of high boron level on plant growth. Similar results were obtained by **Girgis (1982) and Kassem *et al.* (2009)** who found that spraying cotton with 1000 ppm increased plant height.

2. *Position of first fruiting node*

Position of first fruiting node was not significantly affected by the addition of boron fertilizer in both growing seasons (Table 3). The average position of first fruiting node due to 0, 700 and 1400 gm / fed boric acid were 8.59, 8.75 and 8.84 in the first season, respectively, while the values for the second season were 9.14, 9.25 and 9.35, respectively. These results are in accordance with those recorded by **Ahmed *et al.* (1992)**, who reported that no. of first fruiting node was not affected by boron application

3. *Number of fruiting branches / plant*

The effect of boron fertilizer on number of fruiting branches / plant was insignificant in the first season only. In the second

Table (3): Effect of boron fertilization on growth characters of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / boron fertilization rate gm / fed. (c)	Plant height (cm)	Position of first fruiting node	No. of fruiting branches / plant	Leaf area / plant (cm)	Leaf area index
2005 season					
Without boric acid	108.12	8.59	14.90	1670.2	1.39
700 gm / fed boric acid	112.04	8.75	15.00	1828.3	1.52
1400 gm / fed boric acid	102.76	8.84	14.81	1663.0	1.39
L.S.D. at 0.05	**3.82**	**N.S.**	**N.S.**	**121.9**	**0.10**
2006 season					
Without boric acid	112.54	9.14	14.22	1638.0	1.36
700 gm / fed boric acid	116.33	9.25	15.44	1793.0	1.49
1400 gm / fed boric acid	111.35	9.35	15.44	1672.0	1.39
L.S.D. at 0.05	**2.39**	**N.S.**	**0.68**	**75.5**	**0.01**

season, there was significant effect on number of fruiting branches / plant. The highest number of fruiting branches / plant (15.44) was observed for applying 700 gm boric acid / fed or 1400 gm boric acid / fed. While, the lowest number (14.22) was obtained from without boron treatment. These results are confirmed by **Saeed (2000), Wassel *et al.* (2000), Sundaran and Kumor (2005) and Kassem *et al.* (2009)**, who reported that boron application increased number of fruiting branches / plant.

4. *Leaf area / plant (cm^2)*

Results in Table (3) show that boron fertilizer had significant effects on leaf area / plant in both seasons. The highest values of leaf area / plant (1828.3 and 1793.0 cm^2) were found from spraying 700 gm / fed boric acid in 2005 and 2006 seasons respectively. While, the lowest value (1663.0 cm^2) was obtained from applying 1400 gm / fed boric acid in the first season. In the second season, the lowest value (1638.0 cm^2) was showed from zero level of boron. These results are in harmony with those obtained by **Zhao and Oosterhuis (2003).**

5. *Leaf area index*

Results recorded in Table (3) illustrate that boron fertilizer significantly affected leaf area index in both seasons. The highest values (1.52 and 1.49) were observed from applying 700 gm / fed boric acid. On the other side, the lowest values (1.39 and 1.36) were obtained from zero boric acid treatments in 2005 and 2006 seasons, respectively. These results confirmed by **Zhao and Oosterhuis (2003), Sundaran and Kumor (2005)** and **El-Gabiery (2006).** It was observed that the experimented field suffer from lack of boron, although the total requirements by

plants were trace amounts. Therefore, when boron fertilizer was added either in the lower rate (700 gm / fed) or in the higher rate (1400 gm / fed) revealed a great effect on the growth characters of cotton plants. Boron is essential for germination of pollen grains and growth of pollen tubes and essential for pumping ATP as activity and K^+ uptake.

The increase of plant height of cotton plants could be attributed to stimulation of cell division and elongation of the new cells growth formed especially apical meristems, consequently increasing the plant height, and the hormones levels in plant tissues especially the IAA and GA, **(Woodruff *et al.*, 1987 and Albers *et al.*, 2008)**.

D. Effect of the interaction:

a. Effect of the interaction between planting dates and potassium fertilization (A x B) on:

1. *Plant height (cm)*

The results in Table (4) concern with the interaction between planting dates and potassium fertilizer (A x B), the interaction had significant effects on plant height in the first season only. The tallest plants (112.89 cm) were obtained with planting date on 15 April and applying 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages, while the shortest plants (103.17 cm) were obtained at the interaction between the early planting date (15 March) and from applying 24 kg K_2O / fed as soil application after thinning. These results are confirmed by **Abou-Zeid *et al.* (1997)** and **Abou El-Nour *et al.* (2000).**

Table (4):Effect of the interaction between planting dates and potassium fertilization (A x B) on growth characters of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Treatments		Plant height (cm)	Position of first fruiting node	No. of fruiting branches / plant	Leaf area / plant (cm)	Leaf area index
2005 season						
A1	B1	103.17	8.46	14.54	1786.6	1.50
	B2	103.72	8.31	14.79	1450.0	1.21
	B3	107.49	8.49	16.02	1481.1	1.23
A2	B1	107.90	9.03	14.42	1833.5	1.53
	B2	110.68	8.93	14.70	2112.4	1.76
	B3	112.89	9.18	14.95	1659.2	1.38
L.S.D. at 0.05		**4.85**	**0.47**	**0.44**	**161.9**	**0.13**
2006 season						
A1	B1	111.52	8.68	14.78	1767.0	1.47
	B2	113.54	8.61	15.19	1471.0	1.22
	B3	114.62	8.72	15.29	1497.0	1.24
A2	B1	112.13	9.93	14.83	1785.0	1.49
	B2	114.27	9.72	15.08	2019.0	1.68
	B3	114.37	9.86	15.02	1669.0	1.39
L.S.D. at 0.05		**N.S.**	**0.73**	**N.S.**	**113.4**	**0.09**

A1 : Early planting at 15 March.

A2: Late planting at 15 April

B1: 24 kg K_2O/fed as soil application after thinning.

B2: 24 kg K_2O/fed as soil application after thinning + 2.4 kg K_2O/fed spray at flowering stage..

B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage.

2. *Position of first fruiting node*

The interaction between planting dates and potassium fertilizer (A x B) is shown in Table (4) significant effects on position of first fruiting node is observed in both seasons. The lower node (8.31 and 8.61) were obtained with planting date on 15 March and by applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage in 2005 and 2006 seasons, respectively. While the higher node (9.18) was recorded with planting date on 15 April and applying 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages in the first season.

However, the higher node (9.93) was obtained with planting dates at 15 April and from applying 24 kg K_2O / fed as soil application after thinning in the second season. In contrast, **Abou El-Nour *et al.* (2000)** found insignificant effect interaction between planting dates and potassium fertilizer on position of first fruiting node

3. *Number of fruiting branches / plant*

Regarding the interaction between planting dates and potassium fertilizer, it had significant effects on number of fruiting branches / plant in the first season only. The highest number of fruiting branches / plant (16.02) was obtained from the early planting date (15 March) and applying 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages. However, the lowest number of fruiting branches / plant (14.42) was recorded from the interaction between late planting date at 15 April and applying 24 kg K_2O / fed as soil application after thinning.

4. *Leaf area / plant (cm^2)*

Results in Table (4) show that the differences in leaf area / plant due to planting dates and potassium fertilizer interaction (A x B) were significant in both seasons. The highest values of leaf area / plant (2112.4 and 2019.0 cm^2) were obtained with planting on 15 April and fertilized by 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While, the lowest values of leaf area / plant (1450.0 and 1471.0 cm^2) were obtained with planting on 15 March and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed sprayed at flowering stage in 2005 and 2006 season, respectively.

5. *Leaf area index*

The interaction A x B as exhibited significant effects on leaf area index in both seasons. The highest values of leaf area index (1.76 and 1.68) were obtained from the late planting and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While, the lowest values of leaf area index (1.21 and 1.22) were obtained from early planting date and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage in 2005 and 2006 seasons, respectively.

b. Effect of the interaction between planting dates and boron fertilization (A x C) on:

1. *Plant height (cm)*

The interaction between planting date and boron treatments (A x C) as shown in Table (5), had significantly effects on plant height in the first season only. The results revealed that the

Table (5):Effect of the interaction between planting dates and boron fertilization (A x C) on growth characters of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Treatments		Plant height (cm)	Position of first fruiting node	No. of fruiting branches / plant	Leaf area / plant (cm)	Leaf area index
2005 season						
A1	C1	104.46	8.12	15.13	1543.0	1.28
	C2	109.38	8.43	15.02	1796.5	1.50
	C3	100.54	8.71	15.21	1378.2	1.16
A2	C1	111.78	9.07	14.68	1797.3	1.50
	C2	114.70	9.08	14.98	1860.1	1.55
	C3	104.68	8.98	14.41	1947.8	1.62
L.S.D. at 0.05		**5.50**	**0.38**	**N.S.**	**72.5**	**0.15**
2006 season						
A1	C1	112.27	8.57	14.27	1519.0	1.26
	C2	115.10	8.65	15.50	1790.0	1.49
	C3	112.31	8.79	15.50	1426.0	1.19
A2	C1	112.82	9.75	14.18	1758.0	1.47
	C2	117.56	9.84	15.38	1797.0	1.50
	C3	110.39	9.72	15.38	1918.0	1.60
L.S.D. at 0.05		**N.S.**	**0.39**	**0.96**	**106.8**	**0.09**

A1 : Early planting at 15 March.

A2: Late planting at 15 April.

C1: Without boric acid.

C2: 700 gm / fed boric acid.

C3: 1400 gm / fed boric acid.

tallest plants (114.7 cm) were observed form planting on 15 April and fertilized with 700 gm / fed boric acid. Meanwhile, plants supplied with 1400 gm / fed boric acid and planted on 15 March give the shortest plants (100.54 cm).

2. *Position of first fruiting node*

The results in Table (5) show that the interaction between planting dates and boron fertilizer (A x C), had significant effects on position of first fruiting node in both seasons. Low nodes (8.12 and 8.57) were obtained when planting date was 15 March without boron application. In contrast, the higher nodes (9.08 and 9.84) were obtained with planting on 15April and applying 700 gm / fed boric acid in 2005 and 2006 seasons, respectively.

3. *Number of fruiting branches / plant*

With respect of the interaction between planting dates and boron fertilizer (A x C), resultes in Table (5) reveal that there was significant effects on number of fruiting branches / plant in the second season only. The highest number of fruiting branches / plant (15.50) was obtained from the early planting date on 15 March and applying 700 gm / fed boric acid or 1400 gm / fed boric acid. On the other side, the lowest number of fruiting branches / plant (14.18) was resulted from the late planting and without boron fertilizer.

4. *Leaf area / plant (cm^2)*

Table (5) illustrates that the differences in leaf area / plant due to the interaction between planting date and boron fertilizer (A x C) were significant in both seasons. The highest values of leaf area / plant (1947.8 and 1918.0 cm^2) were observed when

planting occurred on 15 April and applying 1400 gm / fed boric acid. However, the lowest values of leaf area / plant (1378.2 and 1426.0 cm^2) were obtained when planting occurred on 15 March and applying 1400 gm / fed boric acid in 2005 and 2006 seasons, respectively.

5. *Leaf area index*

As shown in Table (5), the differences in leaf area index due to planting date and boron fertilizer interaction were significant in the two seasons. The highest values of leaf area index (1.62 and 1.60) were noticed with planting on 15 April and applying 1400 g / fed boric acid. However, the lowest values of leaf area index (1.16 and 1.19) were obtained when planting at 15 March and applying 1400 gm / fed boric in 2005 and 2006 seasons, respectively.

c.Effect of the interaction between potassium and boron fertilization (B x C) on:

1. *Plant height (cm)*

From the results in Table (6), it is evident that, the interaction between potassium and boron fertilizers (B x C), had significant effects on plant height in both seasons. The tallest plants (114.72 cm) was obtained from applying 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages and 700 gm / fed boric acid, in the first season, and (117.59 cm) from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid in the second season. On the other hand, the shortest plants (99.15 and 109.03 cm) was observed from

Table (6): Effect of the interaction between potassium and boron fertilization (B x C) on growth characters of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Treatments		Plant height (cm)	Position of first fruiting node	No. of fruiting branches / plant	Leaf area / plant (cm)	Leaf area index
2005 season						
B1	C1	107.06	8.68	14.69	1869.2	1.56
	C2	110.40	8.84	14.58	1942.3	1.62
	C3	99.15	8.72	14.18	16.18.8	1.36
B2	C1	107.16	8.29	14.48	1613.7	1.35
	C2	111.02	8.73	14.95	1883.9	1.57
	C3	103.43	8.82	14.81	1846.0	1.54
B3	C1	110.16	8.81	15.54	1522.7	1.26
	C2	114.72	8.70	15.48	1658.7	1.38
	C3	105.71	8.98	15.44	1524.2	1.27
L.S.D. at 0.05		**6.61**	**0.46**	**1.08**	**211.3**	**0.18**
2006 season						
B1	C1	111.29	9.30	14.41	1807.0	1.50
	C2	115.16	9.14	14.93	1877.0	1.56
	C3	109.03	9.49	15.09	1643.0	1.37
B2	C1	112.13	9.09	14.71	1557.0	1.30
	C2	117.59	9.14	15.30	1847.0	1.54
	C3	112.00	9.26	15.40	18.31.0	1.52
B3	C1	114.21	9.10	13.54	1551.0	1.28
	C2	116.24	9.46	16.10	1656.0	1.38
	C3	113.03	9.31	15.84	1541.0	1.28
L.S.D. at 0.05		**4.15**	**N.S.**	**1.17**	**130.8**	**0.11**

B1: 24 kg K_2O/fed as soil application after thinning.
B2: 24 kg K_2O/fed as soil application after thinning + 2.4 kg K_2O/fed spray at flowering stage.
B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage.
C1: Without boric acid.
C2: 700 gm / fed boric acid.
C3: 1400 gm / fed boric acid.

applying 24 kg K_2O / fed as soil application after thinning and 1400 gm / fed boric acid in 2005 and 2006 respectively.

2. *Position of first fruiting node*

The interaction between potassium and boron fertilizers in Table (6), it had significant effect on position of first fruiting node in the first season only. The lowest node (8.29) was obtained with applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed as foliar spraying at flowering stage and without boron. While, the higher node (8.98) was obtained from applying 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages and 1400 gm / fed boric acid.

3. *Number of fruiting branches / plant*

The interaction B x C, had significant effects on number of fruiting branches / plant in both seasons. The highest number of fruiting branches / plant (15.54) was obtained from applying 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages and without boron treatment. While, the lowest number of fruiting branches / plant (14.18) was obtained from applying 24 kg K_2O / fed after thinning and 1400 gm / fed boric acid in the first season. In the second season, the highest number of fruiting branches / plant (16.10) was obtained from applying 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid. But, the lowest number of fruiting branches / plant (13.54) was recorded from applying 2.4 kg K_2O / fed spraying twice at squaring stage and flowering stages without boron fertilization.

4. *Leaf area / plant (cm^2)*

With reference to Table (6), the differences in leaf area / plant (cm^2) due to potassium and boron fertilizer interaction were significant in both seasons. The highest values of leaf area / plant (1942.3 and 1877.0 cm^2) were obtained from applying 24 kg K_2O / fed as soil application after thinning and applying 700 gm / fed boric acid. While, the lowest value of leaf area / plant (1522.7 cm^2) in the first season when applying 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages and without boron while, in the second season, the lowest vaule of leaf area (1541 cm^2) and was obtained under 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages and applying 1400 gm / fed boric acid.

5. *Leaf area index*

As shown in Table (6), the differences in leaf area index due to potassium and boron fertilizer interaction (B x C) were significant in both seasons. The highest values (1.62 and 1.56) were obtained from applying 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid. However, the lowest values (1.26 and 1.28) were obtained from applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and without boron fertilizer in 2005 and 2006 seasons, respectively. Combining boron with potassium as foliar application may enhance plant uptake and yield on soils. These two elements play significant role in carbohydrate metabolism and translocation in plants. As a result, choosing the appropriate time of planting and application potassium and boron fertilizers in the suitable and affective dose gave the greatest effects on the growth characters

of cotton plants, which may be converted to high yield and high quality.

d. Effect of the interaction between planting dates, potassium and boron fertilization(A x B x C) on:

1. *Plant height (cm)*

Results in Tables (7 and 8), show that the interaction between the three factors (A x B x C) had significant effects on plant height in the two seasons. The tallest plants (116.43 cm) were obtained with planting on 15 April and gave 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering and 700 gm / fed boric acid in the first season. In the second season, the tallest plants (119.97 cm) were obtained when planting on 15 April and supplied with 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and 700 gm / fed boric acid. While, the shortest plants (99.15 and 107.05 cm) were found when planting date was 15 March, 24 kg K_2O / fed as soil application after thinning and applying 1400 gm / fed boric acid in 2005 and 2006 seasons, respectively.

2. *Position of first fruiting node*

From Tables (7 and 8), it can be noticed that interaction between the three factors (A x B x C) had significant effects on position of first fruiting node in both seasons. The lower node (7.82) was noticed when planting date was on 15 March and fertilized with 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and without boron treatment. The highest node (9.42) was obtained when planting at 15 April, 2.4 kg K_2O / fed as foliar spraying twice was on squaring and flowering stages and without boron in the first

Table (7):Effect of the interaction between planting date, potassium and boron fertilization (A x B x C) on growth characters of cotton plant (Giza 80) in 2005 season.

Characters / Treatments			Plant height (cm)	Position of first fruiting node	No. of fruiting branches / plant	Leaf area / plant (cm^2)	Leaf area index
A1	B1	C1	102.47	8.32	14.18	1682.7	1.40
		C2	107.90	8.45	14.43	2228.0	1.85
		C3	99.15	8.60	15.02	1449.2	1.23
	B2	C1	104.13	7.82	15.08	1553.0	1.30
		C2	107.25	8.40	14.70	1450.3	1.21
		C3	99.78	8.70	14.60	1346.7	1.12
	B3	C1	106.78	8.20	16.13	1393.3	1.14
		C2	113.00	8.45	15.93	1711.3	1.43
		C3	102.70	8.82	16.00	1338.7	1.12
A2	B1	C1	111.65	9.02	15.20	2055.6	1.71
		C2	112.90	9.23	14.73	1656.7	1.38
		C3	99.15	8.85	13.33	1788.3	1.49
	B2	C1	110.18	8.77	13.88	1674.3	1.40
		C2	114.78	9.07	15.20	2317.6	1.93
		C3	107.07	8.95	15.02	2345.3	1.95
	B3	C1	113.53	9.42	14.95	1662.0	1.38
		C2	116.43	8.95	15.02	1606.0	1.34
		C3	108.72	9.15	14.88	1709.7	1.42
L.S.D. at 0.05			**9.35**	**0.65**	**1.53**	**298.8**	**0.25**

A1: Early planting at 15 March.
A2: Late planting at 15 April.
B1: 24 kg K_2O/fed as soil application after thinning.
B2: 24 kg K_2O/fed as soil application after thinning. + 2.4 kg K_2O/fed spray at flowering stage.
B3: 2.4 kg K_2O/fed as spray at squaring stage +2.4 kg K_2O/fed spray at flowering stage.
C1: Without boric acid.
C2: 700 gm / fed boric acid.
C3: 1400 gm / fed boric acid.

Table (8): Effect of the interaction between planting date, potassium and boron fertilization (A x B x C) on growth characters of cotton plant (Giza 80) in 2006 seasons.

Characters / Treatments			Plant height (cm)	Position of first fruiting node	No. of fruiting branches / plant	Leaf area / plant (cm^2)	Leaf area index
A1	B1	C1	110.95	8.50	14.68	1626.0	1.35
		C2	116.57	8.68	14.75	2168.0	1.80
		C3	107.05	8.88	14.93	1506.0	1.25
	B2	C1	110.53	8.70	14.77	1529.0	1.27
		C2	115.20	8.38	15.07	1513.0	1.26
		C3	114.88	8.75	15.78	1371.0	1.14
	B3	C1	115.32	8.52	15.35	1401.0	1.15
		C2	113.53	8.90	16.73	1690.0	1.40
		C3	115.00	8.75	15.80	1402.0	1.17
A2	B1	C1	111.63	10.10	14.15	1988.0	1.65
		C2	113.75	9.60	15.16	1586.0	1.33
		C3	111.00	10.10	15.25	1780.0	1.48
	B2	C1	113.72	9.48	14.65	1585.0	1.32
		C2	119.97	9.90	15.57	2181.0	1.82
		C3	109.13	9.77	15.02	2292.0	1.91
	B3	C1	113.10	9.68	13.73	1702.0	1.42
		C2	118.95	10.02	15.48	1623.0	1.35
		C3	111.05	9.88	15.88	1681.0	1.40
L.S.D. at 0.05			**5.87**	**0.68**	**1.66**	**184.9**	**0.15**

A1: Early planting at 15 March.

A2: Late planting at 15 April.

C1: Without boric acid.

C2: 700 gm / fed boric acid.

C3: 1400 gm / fed boric acid.

B1: 24 kg K_2O/fed as soil application after thinning.

B2: 24 kg K_2O/fed as soil application after thinning. + 2.4 kg K_2O/fed spray at flowering stage.

B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage.

season. In the second season the lowest node (8.38) was obtained when planting was on 15 March,24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid. The highest node (10.10) was obtained when planting at 15 April, 24 kg K_2O / fed after thinning and without boron or 1400 gm / fed boric acid.

3. *Number of fruiting branches / plant*

It is clear to notice in Tables (7 and 8) that, the interaction between the three factors (A x B x C) had significant effects on number of fruiting branches / plant in both seasons. The highest number of fruiting branches / plant (16.13) was obtained from the early planting date (15 March), 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages and without boron fertilizer. While, the lowest number of fruiting branches / plant (13.33) resulted from the late planting date at 15 April, 24 kg K_2O / fed as soil application after thinning and applying 1400 gm / fed boric acid in the first season. In the second season, the highest number of fruiting branches / plant (16.73) was obtained from the early planting date of 15 March, 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and 700 gm / fed boric acid. While, the lowest number of fruiting branches / plant (13.73) was obtained from the late planting date, 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages and zero boron.

4. *Leaf area / plant (cm^2)*

Data given in Tables (7 and 8) reveal that leaf area / plant was significantly affected by the interaction among planting dates x potassium x boron fertilizer (A x B x C), in both seasons.

The highest values (2345.3 and 2292.0 cm^2) were obtained when planting date of 15 April, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 1400 gm / fed boric acid in 2005 and 2006, respectively. While the lowest value of leaf area / plant (1338.7 cm^2) was resulted when planting date was 15 March, 2.4 kg K_2O / fed as foliar spraying twice at squaring and flowering stages and applying 1400 gm / fed boric acid in the first season, and (1371.0 cm^2) was obtained when planting was 15 March, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed as foliar spraying at flowering stage and applying 1400 gm / fed boric acid in the second season.

5. *Leaf area index*

With reference to Tables (7 and 8), it is evident that the interaction among three factors (A x B x C) had significant effects on leaf area index in both seasons. The highest values of leaf area index (1.95 and 1.91) were obtained from late planting date of 15 April, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 1400 gm / fed boric acid. On the other hand, the lowest values of leaf area index (1.12 and 1.14) was resulted from the early planting date at 15 March, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 1400 gm / fed boric acid in 2005 and 2006 seasons, respectively.

II. Yield and yield components characters:

A. Effect of planting dates on:

1. *Boll setting percentage*

The results in Table (9) indicate that planting dates possessed significant effect on boll setting percentage in the second season (2006). The highest value (87.27 %) was obtained from the earlier planting date at 15 March. While, the lowest value (84.93 %) was recorded from the late planting date at 15 April. Because of the relatively longer period of vegetative growth in favour of early planting this enhance early sown plants capacity for more utilization of light interception and nutrients uptake. This in turn increased synthesis of carbohydrates as well as mineral contents in cotton plant tissues.

2. *Number of open bolls / plant*

Apparently from Table (9), planting dates significantly affected the number of open bolls / plant in the first season only. The average number of open bolls / plant for planting date of 15 March and 15 April were 14.26 and 15.51 in the first season, respectively. It is obvious that the late planting date produce the highest number of open bolls / plant.

3. *Boll weight (gm)*

Concerning the effect of planting dates on boll weight Table (9), it was evident that planting date significantly affected this trait in the second season. The highest boll weight (3.22 gm) was found in the earlier planting date at 15 March. While, the lowest boll weight (3.05 gm) was recorded for the late planting date at 15 April. The increment in boll weight could be ascribed to early

Table (9): Effect of planting dates on yield and yield components of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Planting date (A)	Boll setting %	No. of open bolls/ plant	Boll weight (gm)	Seed cotton yield / plant (gm)	Seed cotton yield / fed. (kentar)*	Earliness %	Lint %	Seed index (gm)
2005 season								
15 March	77.92	14.26	2.58	37.34	8.19	67.39	41.62	9.59
15 April	73.39	15.51	2.57	39.99	8.95	54.71	41.41	9.51
L.S.D. at 0.05	**N.S.**	**1.15**	**N.S.**	**N.S.**	**0.70**	**N.S.**	**N.S.**	**N.S.**
2006 season								
15 March	87.27	12.06	3.22	38.81	8.60	61.22	39.76	12.25
15 April	84.93	13.24	3.05	41.44	9.23	61.50	38.31	11.46
L.S.D. at 0.05	**2.33**	**N.S.**	**0.08**	**N.S.**	**0.53**	**N.S.**	**0.19**	**0.58**

* One kentar = 157.5 kg.

planting which was characterized by longer vegetative growth period which in turn led to more production of synthetic materials. Consequently, the capacity of plants to produce heavier bolls is expected. Similar results were observed by **Abd El-Zaher (1995), Kassem (1999) and El-Fesheikawy (2003).**

4. *Seed cotton yield / plant (gm)*

The results in Table (9) indicate that planting dates had no effect on seed cotton yield / plant in both seasons. In general, the average seed cotton yield / plant at 15 March and 15 April were 37.24 and 39.99 gm / plant in first season, respectively. The corresponding values for

the second seasons were 38.81 and 41.44 gm / plant. These are in general accordance with those reported by **Afify (1986), Abd El-Zaher (1995)** and **El-Fesheikawy (2003).**

5. *Seed cotton yield / fed (kentar)*

Apparently, there were significant effects on seed cotton yield / fed due to planting dates in both seasons Table (9). The average mean of seed cotton yield (kentar / fed) of 15 March and 15 April were 8.19 and 8.95 kentar / fed in the first season, respectively. The corresponding values for the second season were 8.60 and 9.23 kentar / fed. The increment in seed cotton yield / fed of late planting is mostly by explained to the effect of late planting on increasing some yield components, such as no. of open bolls / plant, boll weight and seed cotton yield / plant **Abd El-Zaher (1995).**

6. *Earliness percentage*

Results in Table (9) showed insignificant effects on earliness percentage by panting date in both seasons. The average earliness percentage for 15 March and 15 April were 67.39 and 54.71 % in the first season, respectively. The corresponding earliness percentages for the second season were 61.22 and 61.50 %.

7. *Lint percentage (%)*

Concerning the effect of planting date on lint percentage, the results as shown in Table (9) indicate that there were significant effects in the second season 2006 only. The highest value (39.76 %) was obtained from the early planting date at 15 March. While the lowest value (38.31 %) was found from the late planting date of 15 April. The increases in such trait of early planting could be explained by the relative increase in lint yielded accompanied with seed cotton yield compared with late planting. Similar results obtained by **El-Debaby *et al.* (1995 b), Hosny and Shahine (1995), El-Tabbakh (2001) and Killi (2005).**

8. *Seed index (100-seed weight)*

The result indicated that seed index was significantly affected by planting date in the second season 2006. The highest seed index (12.25 gm) was obtained from early planting date of 15 March. While, the lowest seed index (11.46 gm) was noticed from late planting date of 15 April. This indicates that early planting on March had higher capacity for producing more metabolites per unit weight what is reflected on 100-seed weight than late planting on April. The previous results took the same

trend with the results of **Abd El-Zaher (1995), Kassem (1999) and El-Fesheikawy (2003).**

From this recent study, it is evident that cotton plants in this special case preferred to be planted late, may this attitude refers to the suitable climatic conditions in this date (i.e., soil, temperature, air temperature, relative humidity, light interception ...etc.) which enhance the physiological processes and balance the plant hormones and improve the activities of some specific enzymes then improve yield and yield components (i.e., number of fruiting branches and open bolls / plant, boll weight, seed index, seed cotton yield / plant and lint percentage).

B. Effect of potassium fertilization on:

1. *Boll setting percentage*

Concerning the effect of potassium fertilizer on boll setting percentage Table (10), it was clear that potassium fertilizer significantly affected this trait in the second season. The highest value (87.21 %) was resulted from applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages. While, the lowest value (85.47 %) obtained from 24 kg K_2O / fed as soil application after thinning. This may be due to the greater accumulation of sugars and starch in leaves under potassium efficient conditions affects development of bolls due to efficiency of metabolites. In this respect, **Dordas (2006)** supported the previous results.

2. *Number of open bolls / plant*

With respect to potassium fertilizer, it is evident that potassium treatments significantly affected number of open bolls / plant in the second season only. In the second season, the

Table (10): Effect of potassium fertilization on yield and yield components of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Potassium fertilization (K_2O/fed) (B)	Boll setting %	No. of open bolls / plant	Boll weight (gm)	Seed cotton yield / plant (gm)	Seed cotton yield / fed. (kentar)	Earliness %	Lint %	Seed index (gm)
2005 season								
24 kg after thinning.	75.30	15.10	2.51	37.96	8.25	58.77	40.89	9.65
24 Kg after thinning + 2.4 kg spray at flowering stage.	75.44	14.50	2.61	38..50	8.38	63.01	41.69	9.30
2.4 kg spray at squaring stage + 2.4 kg spray at flowering stage.	76.25	16.05	2.60	42.27	9.20	61.38	41.96	9.65
L.S.D. at 0.05	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**0.18**
2006 season								
24 kg after thinning.	85.47	11.95	3.19	38.21	8.39	60.10	38.70	12.02
24 Kg after thinning + 2.4 kg spray at flowering stage.	85.60	12.50	3.07	38.33	8.85	62.60	39.18	11.66
2.4 kg spray at squaring stage + 2.4 kg spray at flowering stage.	87.21	13.51	3.14	42.50	9.50	61.38	39.23	11.89
L.S.D. at 0.05	**1.40**	**1.43**	**N.S.**	**N.S.**	**0.84**	**N.S.**	**0.10**	**N.S.**

highest number (13.51) was obtained for applying 2.4 kg K_2O / fed spraying at squaring stage + 2.4 kg K_2O / fed spraying at flowering stage. And the lowest number (11.95) was found for applying 24 kg K_2O / fed after thinning. These results are supported by **Abou El-Nour *et al.* (2000)** and **Pervez *et al.* (2004)**.

3. *Boll weight (gm)*

Results in Table (10) clearly show that, potassium fertilization had insignificant effect on boll weight in the two growing seasons. The average boll weight for potassium rate of 24 kg after thinning, 24 kg applied after thinning + 2.4 kg spraying at flowering stage and 2.4 spraying as foliar twice at squaring and flowering stages were 2.51, 2.61 and 2.60 gm in the first season, respectively. The corresponding values for the second season were 3.19, 3.07 and 3.14 gm.

4. *Seed cotton yield / plant (gm)*

The results in Table (10) clearly show that potassium fertilization had insignificant effects on seed cotton yield / plant in both seasons. The average seed cotton yield / plant for the three potassium treatments (24 kg after thinning, 24 kg after thinning + 2.4 kg spraying at flowering stage and 2.4 kg spraying as foliar twice at squaring and flowering stages) were 37.96, 38.50 and 42.27 gm / plant in the first season, respectively. The corresponding values for the second season were 38.21, 38.33 and 42.50 gm / plant, respectively.

5. *Seed cotton yield / fed* (kentar)

The results given in Table (10) indicate that potassium fertilizer had significant effects on seed cotton yield / fed in the

second season only. The highest seed cotton yield (9.50 kentar / fed) was obtained by applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages. While, the lowest seed cotton yield / fed (8.39 kentar / fed) was obtained from applying 24 kg K_2O / fed as soil application after thinning. This increase may be due to that spraying at squaring and flowering twice gave the highest value of no. of open bolls and seed cotton yield / plant. These results are confirmed by **Abd El-Aal *et al.*(1990), Abou El-Nour *et al.* (2000), Kassem and Ahmed (2005) and Sharma and Singh (2007).**

6. *Earliness percentage*

Results in Table (10) clearly show that earliness percentage was not affected by potassium fertilizer in both seasons. The average of earliness percentage to added potassium treatments as 24 kg after thinning, 24 kg after thinning + 2.4 kg spraying at flowering stage and 2.4 spraying as foliar twice at squaring and flowering stages were 58.77, 63.01 and 61.38 % in the first season, respectively and 60.10, 62.60 and 61.38 %, for the second season in the same order.

7. *Lint percentage (%)*

Results presented in Table (10) show that potassium fertilizer had a significant effect on lint percentage in the second season only. The highest value (39.23 %) was obtained from applying 2.4 kg K_2O / fed spraying at squaring stage + 2.4 kg K_2O / fed spraying at flowering stage. However, the lowest value (38.70 %) resulted from applying 24 kg K_2O / fed as soil application after thinning. This may be due to the direct role of potassium on

RNA-synthesis and consequently on protein synthesis, which in turn directly effects fiber growth (**Drawish, 1991**)

8. *Seed index (100-seed weight)*

Results in Table (10) reveal that potassium fertilizer effect significantly varied on seed index in the first season only. The highest seed index (9.65 gm) was obtained from applying 24 kg K_2O / fed after thinning or 2.4 kg K_2O / fed spraying at squaring stage + 2.4 kg K_2O / fed spraying at flowering stage. While, the lowest seed index (9.30 gm) was obtained by applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage. The results might be due to the fact that potassium enhanced seed formation and maturation of cotton fiber consequently increased seed weight. Similar results were confirmed by **Abou-Zeid *et al.* (1997), El-Tabbakh (2002)** and **Kassem and Ahmed (2005).**

Fertile by essential nutrient elements increase the endogenous contents of some essential components as carbohydrates, proteins as well as increasing the activities of some specific enzymes.

Application of potassium increased dry matter accumulation, number of fruiting branches / plant, number of open bolls / plant, boll weight, and consequently increased seed cotton yield / plant and feddan. Also, potassium increased the activity of the enzymes involved in the synthesis of amino acids, which are the main precursor of many auxines. Adding such elements in the suitable dose and in the suitable way and date improve the hormones levels in plant tissues especially the IAA and GA, contents.

Meanwhile, potassium influences crop maturity in different ways. It tends to increase moisture content which may have an indirect effect on physiological maturity as well K increases yield and yield components by allowing plants to take full advantage of soil moisture, sunlight and other plant nutrients.

Potassium may alter cotton growth and development by affecting leaves and bolls in upper canopy. (**Maples, *et al.* 1988 ; Oosterhuis, 1993**).

Meanwhile **Bolt and Bruggenwet (1976)** found that K application exerts high osmatic pressure (e.g. in excess of 5 – 10 bars), which may have a detrimental effect on subsequent crop growth and development.

C. Effect of boron fertilization:

1. *Boll setting percentage*

Table (11) clearly shows that boll setting percentage was not significantly affected by boron fertilization in the two growing seasons. The average boll setting were 75.55, 74.89 and 76.55 % in the first season, for 0, 700 and 1400g, respectively. The corresponding values for the second season were 85.68, 85.57 and 87.04 %.

2. *Number of open bolls / plant*

The results in Table (11), reveal that boron fertilizer had a significant effect on number of open bolls / plant in the first season only. The highest value (16.21) was obtained by applying 700 gm / fed boric acid, while the lowest value (13.65) was obtained without boron fertilization. The increase in number of open bolls / plant due to foliar feeding with boron may be

Table (11): Effect of boron fertilization on yield and yield components of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / boron fertilization rate gm / fed (c)	Boll setting %	No. of open bolls / plant	Boll weight (gm)	Seed cotton yield / plant (gm)	Seed cotton yield / fed. (kentar)	Earliness %	Lint %	Seed index (gm)
2005 season								
Without boric acid	75.55	13.65	2.58	35.29	7.81	62.96	41.58	9.40
700 gm / fed boric acid	74.89	16.21	2.57	41.62	8.94	59.87	42.01	9.52
1400 gm / fed boric acid	76.55	15.15	2.57	39.06	8.80	60.33	40.95	9.66
L.S.D. at 0.05	**N.S.**	**1.00**	**N.S.**	**1.66**	**0.55**	**N.S.**	**N.S.**	**0.24**
2006 season								
Without boric acid	85.68	12.25	3.06	37.57	7.35	62.45	38.94	11.86
700 gm / fed boric acid	85.57	13.44	3.15	42.33	9.45	60.76	39.31	11.78
1400 gm / fed boric acid	87.04	12.68	3.19	40.57	9.11	60.86	38.85	11.93
L.S.D. at 0.05	**N.S.**	**N.S.**	**0.12**	**N.S.**	**1.11**	**N.S.**	**N.S.**	**N.S.**

attributed mainly to the higher number of total flowers / plant and the lower shedding percentage as compared with zero boron (**El-Gabiery, 2006).**

3. *Boll weight (gm)*

The effect of boron fertilizer on boll weight (gm) as shown in Table (11) was significant in the second season only. The highest boll weight (3.19 gm) was obtained from applying 1400 gm / fed boric acid. While, the lowest value (3.06 gm) was obtained from control treatment (zero boron).

Boron increased leaf N, P content which enhances photosynthesis due to its activation of CO_2 fixation in the chloroplast and due to its role in energy transfer processes in both photosynthesis and respiration and this is reflected on producing heavier bolls (**Wassel *et al.* 2000**).

4. *Seed cotton yield / plant (gm)*

Concerning the effect of boron fertilizer on seed cotton yield / plant shown in Table (11); it is clear that boron fertilizer had significant effect on this trait only in the first season. The highest seed cotton yield / plant (41.62 gm) was obtained by applying 700 gm / fed boric acid. Whereas, the lowest value (35.29 gm) was yielded from zero boron. These increment may be attributed to that foliar application of boron gave the highest number of open bolls / plant and heaviest bolls, which was reflected on increasing seed cotton yield / plant. Similar results were obtained by **Girgis (1982), Wassel *et al.* (2000) and Gromus (2006).**

5. *Seed cotton yield / fed (kentar)*

Concerning the effect of boron fertilizer on seed cotton yield / fed shown in Table (11), it was evident that boron fertilizer significantly affected this trait in both seasons. The highest seed cotton yield / fed (8.94 and 9.45 kentar / fed) were obtained from applying 700 gm / fed boric acid. While, the lowest seed cotton yield / fed (7.81 and 7.35kentar / fed) were showed for zero boron in 2005 and 2006 seasons, respectively. The increase in seed cotton yield / fed caused by boron may be attributed to that boron gave the highest number of fruiting branches / plant, no. of open bolls / plant, boll weight and seed cotton yield / plant which led to increase seed cotton yield (kentar / fed). Similar results were reported by **Wassel *et al.* (2000)** and **Groums (2006).**

6. *Earliness percentage*

The results in Table (11) show that earliness percentage was not affected by boron treatments in both seasons. The average earliness percentage due to added boron at 0, 700 and 1400 gm / fed boric acid were 62.96, 59.87 and 60.33 % in the first season, respectively and 62.45, 60.76 and 60.86 %, in the second season, respectively. In this respect, **Abd El-Aal *et al.* (2000)**, **Wassel *et al.* (2000)** and **El-Sayed and El-Menshawi (2006)** reported that earliness percentage increased by boron fertilizer.

7. *Lint percentage (%)*

From Table (11), it could be seen that, lint percentage was not affected by boron fertilizer in both seasons. The average lint percentage due to added boron at 0, 700 and 1400 gm / fed boric acid were 41.58, 42.01 and 40.95 % in the first season,

Table (12): Effect of the interaction between planting dates and potassium fertilization (A x B) on yield and yield components of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Treatments		Boll setting %	No. of open bolls / plant	Boll weight (gm)	Seed cotton yield / plant (gm)	Seed cotton yield / fed. (kentar)	Earliness %	Lint %	Seed index (gm)
2005 season									
A1	B1	78.13	12.92	2.62	33.96	8.32	65.23	40.27	9.69
	B2	77.87	11.85	2.55	30.13	8.10	69.68	41.98	9.49
	B3	77.78	16.30	2.58	42.04	8.83	67.28	42.59	9.59
A2	B1	72.47	14.42	2.62	37.87	8.07	52.32	41.50	9.76
	B2	73.00	17.36	2.46	42.71	8.54	56.34	41.40	9.06
	B3	74.71	18.80	2.41	45.48	9.41	55.48	41.33	9.71
L.S.D. at 0.05		**5.32**	**1.90**	**0.16**	**3.58**	**N.S.**	**7.84**	**2.02**	**0.26**
2006 season									
A1	B1	87.38	11.96	3.26	38.33	10.11	61.50	39.59	12.31
	B2	85.88	11.95	3.19	37.96	10.22	62.82	39.81	12.19
	B3	88.54	12.54	3.21	40.23	10.62	59.35	39.89	12.24
A2	B1	88.57	13.10	3.11	40.85	9.47	58.70	37.80	11.72
	B2	85.32	13.15	2.95	38.69	10.46	62.38	38.56	11.14
	B3	85.88	14.55	3.07	44.77	11.57	63.41	38.57	11.53
L.S.D. at 0.05		**2.74**	**2.03**	**0.24**	**N.S.**	**1.20**	**N.S.**	**1.42**	**0.72**

A1 : Early planting at 15 March.

A2: Late planting at 15 April.

B1: 24 kg K_2O/fed as soil application after thinning.

B2:24 kg K_2O/fed as soil application after thinning +2.4 kg K_2O/fed spray at flowering stage.

B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage.

planting date and applying 2.4 kg K_2O / fed as spraying twice at squaring and flowering stages. However, the lowest number of open bolls / plant (11.85 and 11.95) were obtained from the early planting date and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage in first and second seasons, respectively. Similar results were obtained by **Abou El-Nour *et al.* (2000)** who found that number of open bolls / plant was significantly affected by the interaction between planting dates and potassium fertilization.

3. *Boll weight (gm)*

Planting dates and potassium fertilizer (A x B) interaction had significant effect on boll weight in both seasons (Table, 12). The highest boll weight (2.62 and 3.26 gm) were observed for the early planting date at 15 March and applying 24 kg K_2O / fed as soil application after thinning. While, the lowest boll weight (2.41 gm) was obtained from the interaction between the late planting and fertilizing by 2.4 kg K_2O / fed spraying twice at squaring and flowering stages in the first season. In the second season the lowest boll weight (2.95 gm) was obtained in the same planting date and by application of K at the rate of 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed sprayed at flowering stage in 2006 season.

4. *Seed cotton yield / plant (gm)*

Results tabulated in Table (12) reveal that, the interaction effect between planting dates and potassium fertilizer (A x B) on seed cotton yield / plant was significant in the first season only. The highest seed cotton yield / plant (45.48 gm) was obtained for the late planting date of 15 April and applying 2.4 kg K_2O / fed

spraying twice at squaring and flowering stages. Whereas, the lowest seed cotton yield / plant (30.13 gm) was shown for the early planting date of 15 March and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage in 2005 season.

5. *Seed cotton yield / fed (kentar)*

Table (12) showed that, the interaction between planting dates and potassium fertilizer (A x B) had insignificant effects on seed cotton yield / fed in the first season, while in the second season, it had a significant effect. The highest seed cotton yield (11.57 kentar / fed) was observed for the late planting date of 15 April and applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages. On the other hand, the lowest seed cotton yield / fed (9.47 K / fed) was obtained from the late planting dates and applying 24 kg K_2O / fed after thinning. In this respect, **Abou El-Nour *et al.* (2000)** reported that seed cotton yield / fed was insignificantly affected by the interaction between planting dates and potassium fertilizer.

6. *Earliness percentage*

Table (12) shows that, earliness percentage was significantly affected by planting dates x potassium fertilizer interaction in the first season only. The highest value (69.68 %) was recorded for the earlier planting date and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While, the lowest value (52.32 %) was obtained from the late planting date of 15 April and applying 24 kg K_2O / fed after thinning.

7. *Lint percentage (%)*

The interaction between planting dates and potassium fertilizer (A x B) as shown in Table (12) had significant effects on lint percentage in both seasons. The highest values (42.59 and 39.89 %) were obtained with planting date of 15 March and applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages in 2005 and 2006 seasons, respectively. Meanwhile, the lowest value (40.27 %) was shown with planting on 15 March and applying 24 kg K_2O / fed after thinning in the first season. In the second season, the lowest value (37.80 %) was obtained from the late planting date and 24 kg K_2O / fed as soil application after thinning. Similar conclusion was reported by **Abou El-Nour *et al.* (2000).**

8. *Seed index (100-seed weight)*

Regarding Table (12), it is evident that, planting dates x potassium fertilizer interaction had significant effects on seed index in both seasons. The highest seed index (9.76 gm) was found from the late planting date and applying 24 kg K_2O / fed after thinning. While, the lowest seed index (9.06 gm) was obtained from the late planting date and applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage in the first season. In the second season, the highest seed index (12.31 gm) was recorded from early planting date and applying 24 kg K_2O / fed after thinning. However, the lowest seed index (11.14 gm) was obtained from the late planting date and 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage. These results are in contrast with those obtained by **Abou**

fed boric acid, while the lowest boll weight (2.99 gm) resulted from the late planting date and without boron.

4. *Seed cotton yield / plant (gm)*:

Results tabulated in Table (13) reveal that, seed cotton yield / plant was significantly affected by planting dates x boron fertilizer interaction in both seasons. The highest seed cotton yield / plant (45.93 and 43.07 g) were obtained when cotton was planted on 15 April and applying 700 gm / fed boric acid. While, the lowest seed cotton yield / plant (33.34 and 36.49 gm) were resulted from planting on 15 March and without boric in both seasons, respectively.

5. *Seed cotton yield / fed (kentar / feddan)*

With reference to Table (13), it could be seen that, seed cotton yield (kentar feddan) was significantly affected by planting dates x boron fertilizer interaction (A x C) in both seasons. The highest seed cotton yield / fed (8.82 and 11.48 kentar / fed) were obtained for late planting and applying 700 g / fed boric acid. However, the lowest seed cotton yield / fed (7.33 and 8.66 kentar / fed) were recorded from the early planting and without boron in both seasons. In addition, it can be observed that seed cotton yield/fed did not significantly respond to planting date in absence of boron in both seasons.

6. *Earliness percentage*

With regard to the effect of the interaction between planting dates and boron fertilization (A x C), it could be noticed from Table (13) that earliness percentage was significantly affected by this interaction in the first season only. The highest value (70.50 %) was obtained from the early planting and without boron.

Meanwhile, the lowest value (53.87 %) was obtained from the late planting and applying 1400 gm / fed boric acid.

7. *Lint percentage (%)*

Planting date x boron fertilizer interaction (Table, 13) had significant effects on lint percentage in the second season only. The highest value (40.14 %) was recorded for the early planting date and without boron fertilizer, while the lowest value (37.75 %) was obtained from the late planting and without boron.

8. *Seed index (100-seed weight)*

As shown in Table (13), planting dates x boron fertilizer interaction (A x C) had significant effects on seed index in both seasons. The highest seed indexes (9.74 and 12.40 gm) were obtained from the early planting and applying 1400 gm / fed boric acid in 2005 and 2006 seasons, respectively. The lowest seed index (9.21 gm) was recorded from the late planting date and without boron in the first season. Meanwhile, the lowest seed index (11.39 gm) was obtained also from the late planting and applying 700 gm / fed boric acid in the second season.

c. Effect of the interaction between potassium and boron fertilization (B x C) on:

1. *Boll setting percentage*

Potassium x boron fertilizer interaction had significant effects on boll setting percentage in the second season. The highest value (88.91 %) was obtained from applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and 1400 gm / fed boric acid. Meanwhile, the lowest value (83.75 %) was

shown for applying 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid.

2. *Number of open bolls / plant*

Table (14) illustrate that, the differences in number of open bolls / plant due to potassium x boron fertilization (B x C) interaction were significant in both seasons. The highest number of open polls / plant (17.45 and 14.94) were recorded for applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid. While, the lowest number of open polls / plant (11.70 and 11.72) resulted from applying 24 kg K_2O / fed after thinning and without boron in 2005 and 2006 seasons, respectively.

3. *Boll weight (gm)*

Potassium x boron fertilizer interaction (B x C) had significant effect on boll weight in both seasons. The highest boll weight (2.71 gm) was obtained from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 1400 gm / fed boric acid. While, the lowest boll weight (2.45 gm) was recorded for applying 24 kg K_2O / fed after thinning and applying 1400 gm / fed boric acid in the first season. In the second season, the highest boll weight (3.26 gm) was shown from applying 24 kg K_2O / fed as soil application after thinning and applying 700 gm / fed boric acid, while, the lowest boll weight (2.97 gm) was obtained from applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed as foliar spraying at flowering stage without boron fertilization.

Table (14): **Effect of the interaction between potassium and boron fertilization (B x C) on yield and yield components of cotton plant (Giza 80) in 2005 and 2006 seasons.**

Characters / Treatments		Boll setting %	No. of open bolls / plant	Boll weight (gm)	Seed cotton yield / plant (gm)	Seed cotton yield / fed. (kentar)	Earliness %	Lint %	Seed index (gm)
2005 season									
B1	C1	76.02	11.70	2.54	29.64	7.41	61.58	41.85	9.58
	C2	73.92	17.20	2.53	43.60	8.25	55.70	39.96	9.92
	C3	75.95	13.86	2.45	33.96	8.93	59.03	40.85	9.47
B2	C1	74.44	12.90	2.57	33.12	7.63	66.19	41.56	9.30
	C2	75.60	13.75	2.56	35.14	8.91	61.54	42.16	9.18
	C3	76.27	14.95	2.71	40.47	8.43	61.30	41.36	9.42
B3	C1	76.18	16.14	2.63	42.44	8.45	61.11	41.34	9.33
	C2	75.14	17.45	2.62	45.75	9.73	62.38	43.92	9.48
	C3	77.42	16.50	2.56	42.00	9.13	60.65	40.64	10.10
L.S.D. at 0.05		**N.S.**	**1.53**	**0.19**	**2.88**	**0.95**	**6.69**	**3.56**	**0.48**
2006 season									
B1	C1	84.89	11.72	3.15	36.83	8.67	62.80	38.11	12.17
	C2	83.75	12.90	3.26	41.92	10.47	60.67	39.37	11.77
	C3	87.78	12.31	3.16	39.88	10.24	56.82	38.61	12.10
B2	C1	85.75	12.37	2.97	38.74	8.62	64.41	39.24	11.64
	C2	86.64	12.49	3.07	38.32	11.20	59.85	39.42	11.63
	C3	84.42	13.42	3.18	37.92	11.20	63.55	38.89	11.72
B3	C1	86.40	12.20	3.06	37.15	9.29	60.15	39.48	11.78
	C2	86.33	14.94	3.12	46.44	12.50	61.77	39.15	11.93
	C3	88.91	13.50	3.25	43.90	11.50	62.21	39.05	11.95
L.S.D. at 0.05		**4.58**	**1.69**	**0.20**	**6.28**	**1.00**	**6.59**	**N.S.**	**0.68**

B1: 24 kg K_2O/fed as soil application after thinning.
B2: 24 kg K_2O/fed as soil application after thinning + 2.4 kg K_2O/fed spray at flowering stage.
B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage.
C1: Without boric acid.
C2: 700 gm / fed boric acid.
C3: 1400 gm / fed boric acid.

4. *Seed cotton yield / plant (gm)*

Concerning the effect of the interaction between potassium and boron fertilizer (B x C) on this trait as shown in Table (14), it could be noticed that seed cotton yield / plant was significantly affected in both seasons. The highest seed cotton yield / plant (45.75 and 46.44 gm) were recorded for applying 2.4 kg K_2O spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid. Whereas, the lowest seed cotton yield / plant (29.64 and 36.83 gm) were obtained from applying 24 kg K_2O / fed as soil application after thinning and applying zero boric acid in 2005 and 2006 seasons, respectively.

5. *Seed cotton yield / fed (kentar)*

From the same Table (14), it is clear that, seed cotton yield (kentar/feddan) was significantly affected by potassium x boron fertilizer interaction (B x C) in both seasons. The highest seed cotton yield / fed (973 and 12.50 kentar / fed) were obtained from applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid in 2005 and 2006 seasons, respectively. However, the lowest seed cotton yield / fed (7.41 kentar / fed) was recorded for applying 24 kg K_2O / fed after thinning and zero boric acid in the first season. In the second season, the lowest seed cotton yield / fed (8.62 kentar / fed) was obtained from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying as foliar at flowering stage and without boric acid. Moreover, from the results of Table (14) it could be mentioned that potassium treatments did not affecte seed cotton yield in absence of fertilization. Also, it could be noticed that 1400 gm / fed boric

acid may be had toxic on some cotton characters as seed cotton yield / fed, specially under the favourable K treatments (2.4 kg K_2O / fed foliar spraying twice at squaring and flowering stages). These results agree with the conclusion of **Tisdale *et al.* (1997)** who reported that at low levels of boron, increased rates of applied K may accentuate boron-deficiency symptoms to extent that boron addition is needed to prevent yield loss. They added that increased K rates may accentuate boron toxicity at high levels of B supply.

6. *Earliness percentage*

From the same Table (14), it could be seen that earliness percentage was significantly affected by potassium x boron fertilizer interaction in both seasons. The highest values (66.19 and 64.41 %) were obtained from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage without boron in 2005 and 2006 seasons, respectively. The lowest value (55.70 %) was shown for applying 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid in the first season. While, the second season, the lowest value (56.82 %) was produced from applying 24 kg K_2O / fed after thinning and applying 1400 gm / fed boric acid.

7. *Lint percentage (%)*

Potassium x boron fertilizer interaction had significant effects on lint percentage in the first season. The highest value (43.92 %) was obtained from applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and 700 gm / fed boric acid. While, the lowest value (39.96 %) was recorded from

applying 24 kg K_2O / fed as soil application after thinning and applying 700 gm / fed boric acid.

8. *Seed index (100-seed weight)*

Results in Table (14) illustrate that, potassium x boron fertilizer interaction (B x C) had significant effect on seed index in both season. In the first season the highest seed index (10.10 gm) was obtained from applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 1400 gm / fed boric acid, while the lowest seed index (9.18 gm) was shown applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage with applying 700 gm / fed boric acid. In the second season, the highest seed index (12.17 gm) resulted from applying 24 kg K_2O / fed after thinning without boron fertilizer. However, the lowest seed index (11.63 gm) was obtained from applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed as foliar spraying at flowering stage and applying 700 gm / fed boric acid. Combining boron with potassium as foliar application may enhance plant uptake and yields on soils, (**Woodruff *et al.*, 1987**).

It is evidence that potassium and boron play a significant role in carbohydrate metabolism and translocation in plants.

d. Effect of the interaction among planting dates, potassium and boron fertilization (A x B x C):

1. *Boll setting percentage*

The interaction between planting dates x potassium x boron fertilizer had significant effects on boll setting percentage in both seasons (Tales 15 and 16). The highest value (80.69 and 91.82 %) resulted from the early planting date, 2.4 kg K_2O / fed

spraying twice at squaring and flowering stages and applying 1400 gm / fed boric acid. While the lowest value (71.13 and 81.28 %) were obtained from the late planting date, 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid in 2005 and 2006 seasons, respectively.

2. *Number of open bolls / plant*

As shown from Tables (15 and 16), the interaction among planting dates x potassium x boron fertilizer (A x B x C), had significant effects on number of open polls / plant in both seasons. The highest number of open polls / plant (19.16 and 15.50) was obtained from the late planting date, 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid in 2005 and 2006 seasons. On the other hand, the lowest number of open polls / plant (13.40 and 11.15) found when cotton was sown on 15 March and fertilized with 24 kg K_2O / fed after thinning and without boron, in 2005 and 2006 seasons, respectively.

3. *Boll weight (gm)*

The three way interaction (A x B x C) had significant effect on boll weight in both seasons (Tables 15 and 16). The highest boll weight (2.73 gm) was obtained from the late planting date, 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 1400 gm / fed boric acid. While, the lowest boll weight (2.44 gm) was obtained from the early or late planting dates, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed or 1400 gm / fed boric acid in the first season. In the second season the highest boll weight (3.36 gm) was obtained from the

Table (15): Effect of the interaction between planting dates, potassium and boron fertilization (A x B x C) on yield and yield components of cotton plant (Giza 80) in 2005 season.

Characters / Treatments			Boll setting %	No. of open bolls / plan	Boll weight (gm)	Seed cotton yield / plant (gm)	Seed cotton yield / fed. (kentar)	Earliness %	Lint %	Seed index (gm)
A1	B1	C1	77.46	13.40	2.61	35.33	9.01	71.05	42.18	9.69
		C2	76.71	15.90	2.56	40.85	10.72	57.34	38.56	9.04
		C3	80.20	14.50	2.68	38.52	10.61	67.29	40.08	9.92
	B2	C1	77.01	14.50	2.60	37.58	8.62	73.40	41.31	9.49
		C2	79.08	15.11	2.61	39.44	10.90	69.63	43.08	9.61
		C3	77.52	15.10	2.44	36.86	11.14	66.01	41.56	9.50
	B3	C1	77.14	13.82	2.66	36.55	8.36	67.05	40.96	9.59
		C2	75.50	16.94	2.59	43.87	12.29	67.74	45.71	9.29
		C3	80.69	16.11	2.50	40.27	11.22	67.04	41.11	9.81
A2	B1	C1	74.57	14.63	2.60	38.34	8.33	52.12	41.52	9.47
		C2	71.13	16.30	2.64	42.99	10.22	54.06	41.36	10.79
		C3	71.70	15.75	2.62	41.24	9.86	50.78	41.62	9.00
	B2	C1	71.87	16.13	2.48	39.90	8.62	58.98	41.81	9.11
		C2	72.12	15.23	2.44	37.19	11.50	53.44	41.23	8.75
		C3	75.02	15.77	2.47	38.99	11.26	56.59	41.17	9.33
	B3	C1	75.23	14.87	2.54	37.76	10.22	55.17	41.72	9.07
		C2	74.77	19.16	2.56	49.02	12.71	57.03	42.12	9.67
		C3	74.14	17.40	2.73	47.54	11.79	54.26	40.16	10.39
L.S.D. at 0.05			**5.32**	**2.44**	**0.27**	**4.08**	**0.27**	**9.46**	**5.04**	**0.59**

A1: Early planting at 15 March.
A2: Late planting at 15 April.
B1: 24 kg K_2O/fed as soil application after thinning.
B2: 24 kg K_2O/fed as soil application after thinning. + 2.4 kg K_2O/fed spray at flowering stage.
B3: 2.4 kg K_2O/fed as spray at squaring stage +2.4 kg K_2O/fed spray at flowering stage
C1: Without boric acid.
C2: 700 gm / fed boric acid.
C3: 1400 gm / fed boric acid.

Table (16): **Effect of the interaction between planting dates, potassium and boron fertilization (A x B x C) on yield and yield components of cotton plant (Giza 80) in 2006 season.**

Characters / Treatments			Boll setting %	No. of open bolls / plant	Boll weight (gm)	Seed cotton yield / plant (gm)	Seed cotton yield / fed. (kentar)	Earliness %	Lint %	Seed index (gm)
A1	B1	C1	86.72	11.15	3.16	39.95	7.60	61.88	39.66	12.29
		C2	86.22	13.00	3.36	43.70	8.18	62.58	39.89	12.02
		C3	89.20	12.07	3.28	39.59	9.33	60.03	39.21	12.63
	B2	C1	86.31	12.60	3.05	34.05	7.75	65.58	40.39	12.18
		C2	89.17	12.38	3.19	39.44	8.54	59.88	39.41	12.36
		C3	82.16	12.32	3.33	41.56	8.07	63.01	39.90	12.03
	B3	C1	88.25	12.80	3.19	40.88	7.66	58.83	36.58	12.08
		C2	85.55	13.85	3.17	43.61	9.65	60.62	38.85	12.13
		C3	91.82	12.10	3.28	39.67	9.20	58.60	38.00	12.53
A2	B1	C1	83.06	12.50	3.15	31.69	7.25	63.71	36.58	12.05
		C2	81.28	13.65	3.15	42.57	8.33	58.76	38.85	11.52
		C3	86.37	12.40	3.03	37.61	8.65	53.62	38.00	11.57
	B2	C1	85.19	12.38	2.89	35.55	7.54	63.24	38.10	11.10
		C2	84.10	15.02	2.94	45.10	9.30	59.81	39.02	10.90
		C3	86.68	15.10	3.03	45.50	8.81	64.09	38.56	11.42
	B3	C1	84.53	14.66	2.93	43.10	9.26	61.48	38.61	11.48
		C2	87.12	15.50	3.06	46.90	9.81	62.92	38.90	11.73
		C3	86.01	13.60	3.22	43.45	9.17	65.82	38.20	11.37
L.S.D. at 0.05			**6.48**	**2.07**	**0.29**	**7.69**	**1.22**	**9.32**	**2.03**	**0.66**

A1: Early planting at 15 March.
B1: 24 kg K_2O/fed as soil application after thinning.
A2: Late planting at 15 April.
B2: 24 kg K_2O/fed as soil application after thinning. + 2.4 kg K_2O/fed spray at flowering stage.
C1: Without boric acid.
C2: 700 gm / fed boric acid.
B3: 2.4 kg K_2O/fed as spray at squaring stage +2.4 kg K_2O/fed spray at flowering stage.
C3: 1400 gm / fed boric acid.

early planting date, 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid. Whereas, the lowest boll weight (2.89 gm) resulted from the late planting date, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage without boron fertilization.

4. *Seed cotton yield / plant (gm)*

The interaction, planting dates x potassium x boron fertilizer (A x B x C), had significant effect on seed cotton yield / plant in both seasons. The highest seed cotton yield / plant (49.02 gm and 46.90 gm) were obtained from the late planting date, 2.4 kg K_2O / fed spraying at squaring stage + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid in 2005 and 2006 seasons, respectively. However, the lowest seed cotton yield / plant (35.33 gm) was obtained from early planting date, 24 kg K_2O / fed after thinning and zero level of boric acid in the first season. In the second season, the lowest seed cotton yield / plant (31.69 gm) was recorded for the interaction between late planting date, 24 kg K_2O / fed as soil application after thinning and without boron fertilization.

5. *Seed cotton yield / fed (kentar)*

The interaction among planting dates x potassium x boron fertilizer had significant effect on seed cotton yield / fed in both seasons. The highest seed cotton yield / fed (12.71 and 9.81 kentar / fed) were obtained from the late planting date, 2.4 kg K_2O/ fed spraying twice at squaring stage and at flowering stages and applying 700 gm / fed boric acid. While, the lowest seed cotton yield / fed (8.33 and 7.25 kentar / fed) were observed for

the late planting date, 24 kg K_2O / fed after thinning and without boron in 2005 and 2006 seasons, respectively.

6. *Earliness percentage*

With regard to Tables (15 and 16), it could be seen that planting dates x potassium x boron fertilizer interaction (A x B x C), had significant effects on earliness percentage in both seasons. The highest value (73.40 %) was recorded from the early planting date, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and without boron. While, the lowest value (50.78 %) was obtained from the late planting date, 24 kg K_2O / fed as soil application after thinning and applying 700 gm / fed boric acid in the first season 2005. In the second season, the highest value (65.82 %) was noticed from the late planting date, 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 1400 gm / fed boric acid, while the lowest value (53.62 %) was obtained from the late planting date, 24 kg K_2O / fed as soil application after thinning and applying 1400 gm / fed boric acid.

7. *Lint percentage (%)*

Results tabulated in Tables (15 and 16) reveal that, planting dates x potassium x boron fertilizer interaction had significant effects on lint percentage in both seasons. The highest value (45.71 %) was obtained from the early planting date, 2.4 kg K_2O / fed spraying twice at squaring and flowering stage and 700 gm / fed boric acid, while the lowest value (38.56 %) was noticed for the early planting, 24 kg K_2O / fed as soil application after thinning and applying 700 gm / fed boric acid in the first season. In the second season, the highest value (40.39 %) was showed

from the early planting date, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and zero level of boric acid. However, the lowest value (36.58 %) was obtained from the late planting date, 24 kg K_2O / fed after thinning and without of boric acid.

8. *Seed index (100-seed weight)*

Planting dates x potassium x boron interaction had significant effects on seed index in both seasons (Tables 15 and 16). The highest seed index (10.79 gm) was obtained from the late planting date, 24 kg K_2O / fed as soil application after thinning and applying 700 gm / fed boric acid. On the other hand, the lowest seed index (8.75 gm) was noticed for the late planting date (15 April), 24 kg K_2O / fed after thinning and applying 1400 gm / fed boric acid in the first season. In the second season, the highest seed index (12.63 gm) was obtained from the early planting date, 24 kg K_2O / fed after thinning and applying 1400 gm / fed boric acid, while the lowest seed index (10.90 gm) was obtained from the late planting date, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid.

III. Fiber properties:

A. Effect of planting dates on:

1. *Fiber length parameters*

It could be seen from Table (17), that the three fiber length parameters i.e., 2.5 % SL, 50 % SL and length uniformity ratio were not affected by planting dates in both seasons.

Table (17): **Effect of planting dates on fiber properties of cotton plant (Giza 80) in 2005 and 2006 seasons.**

Characters / Planting date (A)	Fiber length 2.5 % SL	Fiber length 50 % SL	Uniformity ratio	Pressley index	Micronaire reading
2005 season					
15 March	31.44	25.99	83.32	9.47	4.57
15 April	31.19	25.94	83.29	8.81	4.52
L.S.D. at 0.05	**N.S.**	**N.S.**	**N.S.**	**0.34**	**N.S.**
2006 season					
15 March	31.54	26.32	83.63	9.97	5.00
15 April	31.27	26.11	83.40	9.50	4.78
L.S.D. at 0.05	**N.S.**	**N.S.**	**N.S.**	**0.13**	**N.S.**

2. *Fiber strength (Pressley index)*

Results in Table (17) show that fiber strength (Pressley index) was significantly affected by planting date in both seasons. The highest values (9.47 and 9.97) were obtained from the early planting date (15 March). While, the lowest values (8.81 and 9.50) were obtained from the late planting date in both seasons, respectively. These results are in accordance with the findings obtained by **Shafshak *et al.* (1987) and Abou El-Nour (2000)**, who stated that early planting increased the Pressley index. In general, it seems that fibers take more chance in early planting date conditions to be of stronger quality.

3. *Fiber fineness (micronaire reading)*

It could be noticed from Table (17) that micronaire reading was not affected by planting date in both seasons. Means of micronaire reading were about close (4.57 and 4.52 micronaire unit) in the first season, respectively. The corresponding values for the second season were 5.00 and 4.78 micronaire unit.

B. Effect of potassium fertilization on:

1. *Fiber length parameters*

With respect to potassium fertilizer, results in Table (18) indicate that fiber length (2.5 % SL.) was affected by potassium fertilizer in both seasons. The highest values of fiber length at 2.5 % SL (31.77 and 31.85 mm) were obtained from spraying with 2.4 kg K_2O / fed twice at squaring and flowering stages in the two seasons. While, the lowest values of fiber length at 2.5 % SL. (31.01 and 31.08 mm) were obtained from 24 kg K_2O / fed as soil application after thinning in 2005 and 2006 seasons, respectively. These results are in agreement with those reported

Table (18):Effect of potassium fertilization on fiber properties of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Potassium fertilization (K_2O/fed) (B)	Fiber length 2.5 % SL	Fiber length 50 % SL	Uniformity ratio	Pressley index	Micronaire reading
2005 season					
24 kg after thinning.	31.01	25.66	83.21	8.93	4.44
24 Kg after thinning + 2.4 kg spray at flowering stage.	31.17	25.83	83.42	9.16	4.58
2.4 kg spray at squaring stage + 2.4 kg spray at flowering stage.	31.77	26.41	83.27	9.37	4.60
L.S.D. at 0.05	**0.52**	**0.41**	**N.S.**	**0.35**	**0.14**
2006 season					
24 kg after thinning.	31.08	25.93	83.41	9.62	4.85
24 Kg after thinning + 2.4 kg spray at flowering stage.	31.28	26.11	83.60	9.65	4.85
2.4 kg spray at squaring stage + 2.4 kg spray at flowering stage.	31.85	26.61	83.54	9.94	4.96
L.S.D. at 0.05	**0.51**	**N.S.**	**N.S.**	**N.S.**	**N.S.**

by **Pervez *et al.* (2004), Sawan *et al.* (2006)** and **Sharma and Singh (2007)**, who reported that fiber length significantly responded to K fertilization. Nevertheless, fiber length at 50 % SL. was significantly affected by potassium fertilizer in the first season only (Table, 18). The highest value (26.41 mm) was obtained from the spraying treatments of 2.4 kg K_2O / fed at squaring stage + 2.4 kg K_2O / fed at flowering stage. While, the lowest value (25.66 mm) was obtained from applying 24 kg K_2O / fed as soil application after thinning. These results are in agreement with those reported by **Pervez *et al.* (2004), Sawan *et al.* (2006) and Sharma and Singh (2007)**, who reported that potassium fertilizer had positive effect on fiber length (50 % SL). **Sabino *et al.* (1978) and Sabino *et al.* (1984)** reported that the application of potassium slightly increased 2.5 % and 50 % span lengths.

Results in Table (18) show that uniformity ratio was not affected by potassium fertilizer treatments in both seasons.

2. *Fiber strength (Pressley index)*

With reference to Table (18), the results indicate that fiber strength was significantly affected by potassium fertilizer in the first season only. The highest value (9.37) was found from applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages. The lowest value (8.93) was obtained from applying 24 kg K_2O / fed as soil application after thinning. In the second season the effect of potassium fertilizer on Pressley index was not significant. These results are in the same line with those obtained by **Abou El-Nour *et al.* (2000), Sharma and Singh (2007) and Sawan *et al.* (2008).**

3. *Fiber fineness (micronaire reading)*

The results indicate that fiber fineness was significantly affected by potassium fertilizer in the first season. The highest micronaire reading (4.60 micronaire unit) was obtained from spraying plants with 2.4 kg K_2O / fed twice at squaring and flowering stages. While, the lowest value (4.44 micronaire unit) was recorded for applying 24 kg K_2O / fed as soil treatment after thinning. In the second season, the effect of potassium fertilizer on micronaire reading was not significant. Similar results were observed by **Abou El-Nour *et al.* (2000), Pervez *et al.* (2004) Sharma and Singh, (2007)** and **Sawan *et al.* (2008)**.

Potassium plays an important role in the translocation of photosynthesis from sources to sinks (**Cokmak *et al.*, 1994**). Notable improvements in cotton yield and quality were observed by **Mullins *et al.* (1991) and Cassman *et al.* (1992)**.

Potassium influences crop maturity in different ways. It tends to increase moisture content of plant tissues which may have indirect effect on physiological possesses and maturity as well.

Moreover, potassium improves fiber quality by increasing the metabolism and translocation of carbohydrates to fibers during different phases of their formation.

C. Effect of boron fertilization on:

1. *Fiber length parameters*

It could be noticed from Table (19) that none of the three Fiber length parameters i.e., 2.5 % SL, 50 % SL and length uniformity ratio was affected by boron fertilizer in both seasons.

Table (19): Effect of boron fertilization fiber properties of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / boron fertilization rate gm / fed (c)	Fiber length 2.5 % SL	Fiber length 50 % SL	Uniformity ratio	Pressley index	Micronaire reading
2005 season					
Without boric acid	31.36	25.90	82.98	8.90	4.57
700 gm / fed boric acid	31.23	26.01	83.32	9.20	4.56
1400 gm / fed boric acid	31.36	25.98	83.60	9.36	4.49
L.S.D. at 0.05	**N.S.**	**N.S.**	**N.S.**	**0.35**	**N.S.**
2006 season					
Without boric acid	31.47	26.24	83.38	9.77	4.83
700 gm / fed boric acid	31.30	26.17	83.59	9.73	4.89
1400 gm / fed boric acid	31.44	26.23	83.58	9.71	4.95
L.S.D. at 0.05	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**N.S.**

2. *Fiber strength (Pressley index)*:

The effect of boron fertilizer on fiber strength was significant in the first season (Table 19). The highest value (9.36) was obtained from applying 1400 g / fed boric acid in comparison with zero boron. In the second season, the effect of boron on fiber strength was not significant.

3. *Fiber fineness (micronaire reading)*:

Data in Table (19) show that micronaire reading was not affected by boron fertilization in the two growing seasons. Means of micronaire reading due to foliar spraying with 0, 700 and 1400 g / fed as boric acid was more or less very close to each other. Contradicting results were reported as to the effect of boron on fiber strength, **Anderson and Boswell (1968), Sabino *et al.* (1996) and Saeed (2000)** reported beneficial effect of boron on fiber strength, while **Ahmed *et al.* (1992)**, found no effect on fiber quilty.

D. Effect of the interactions:

a. Effect of the interaction between planting dates and potassium fertilization (A x B) on:

1. *Fiber length parameters*:

Results recorded in Table (20) illustrate that planting dates x potassium fertilization interaction (A x B) exhibited significant effects on fiber length at 2.5 % SL. in 2005 and 2006 seasons. The highest values (32.07 and 32.14 mm) were obtained from the early planting date and spraying with 2.4 kg K_2O / fed twice at squaring and flowering stages. However, the lowest values (30.82 and 30.91 mm) were obtained from the early planting

Table (20): Effect of the interaction between planting dates and potassium fertilization (A x B) on fiber properties of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Treatments		Fiber length 2.5 % SL	Fiber length 50 % SL	Uniformity ratio	Pressley index	Micronaire reading
2005 season						
A1	B1	30.82	25.33	82.94	9.29	4.39
	B2	31.44	26.00	83.67	9.22	4.52
	B3	32.07	26.26	83.44	9.90	4.69
A2	B1	31.20	25.99	83.48	8.58	4.39
	B2	30.89	25.66	83.18	9.09	4.64
	B3	31.48	26.19	83.20	8.84	4.51
L.S.D. at 0.05		**0.73**	**0.58**	**0.73**	**0.50**	**0.19**
2006 season						
A1	B1	30.91	25.68	83.74	9.87	4.96
	B2	31.58	26.44	83.51	9.80	5.01
	B3	32.14	26.82	83.64	10.26	5.02
A2	B1	31.26	26.17	83.09	9.37	4.74
	B2	30.99	25.78	83.69	9.50	4.71
	B3	31.56	26.39	83.43	9.63	4.89
L.S.D. at 0.05		**0.72**	**1.03**	**N.S.**	**0.49**	**0.22**

A1 : Early planting at 15 March.

B1: 24 kg K_2O/fed as soil application after thinning.

A2: Late planting at 15 April.

B2: 24 kg K_2O/fed as soil application after thinning + 2.4 kg K_2O/fed spray at flowering stage..

B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage.

date and applying 24 kg K_2O / fed as soil application after thinning in 2005 and 2006 seasons, respectively. With regard to fiber length at 50 % SL, the interaction between planting date and potassium fertilizer as shown in Table (20) exhibited significant effects in 2005 and 2006 seasons. The highest values (26.26 and 26.82 mm) were obtained from early planting date and spraying with 2.4 kg K_2O / fed at squaring stage + 2.4 kg K_2O / fed spraying at flowering stage.

While, the lowest values (25.33 and 25.68 mm) were obtained from the early planting date and 24 kg K_2O / fed used as soil application after thinning in 2005 and 2006 seasons, respectively. Fiber length uniformity ratio exhibited significant effect for the interaction between planting dates x potassium fertilizer (A x B) in the first season only (Table, 20). The highest value (83.67 %) was obtained from the early planting date and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While, the lowest value (82.94 %) was obtained from the early planting date and applying 24 kg K_2O / fed as soil application after thinning.

2. *Fiber strength (Pressley index)*

With reference to Table (20), planting dates x potassium fertilizer interaction (A x B) exhibited significant effects on fiber strength (Pressley index) in both seasons. The highest values (9.90 and 10.26) resulted from the early planting date and 2.4 kg K_2O / fed sprayed twice at squaring and flowering stage. While, the lowest values (8.58 and 9.37) were obtained from the late planting date and applying 24 kg K_2O / fed as soil application after thinning in 2005 and 2006 seasons, respectively.

3. *Fiber fineness (micronaire reading)*

As shown in Table (20), the interaction between planting dates x potassium fertilizer (A x B) exhibited significant effects on micronaire reading in both seasons. In the first season the highest value of micronaire reading (4.69 micronaire unit) was observed for the early planting date and spraying with 2.4 kg K_2O / fed twice at squaring and flowering stages. However, the lowest value of micronaire reading was obtained from the late planting date and applying 24 kg K_2O / fed as soil application after thinning. In the second season, the highest value of micronaire reading (5.02 micronaire unit) was obtained from the early planting date and spraying with 2.4 kg K_2O / fed at squaring stage + 2.4 kg K_2O / fed sprayed at flowering stage. While, the lowest value of micronaire reading (4.71 micronaire unit) was obtained from the late planting date and 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage.

b. Effect of the interaction between planting dates and boron fertilization (A x C) on:

1. *Fiber length parameters*

The interaction between planting dates x boron fertilizer as shown in Table (21), exhibited significant effects on fiber length at 2.5 % SL. in both seasons. The highest values (31.78 and 31.91 mm) were recorded from the late planting date and zero boron. Whereas, the lowest values (30.94 and 31.03 mm) were measured from the early planting date and zero boron in 2005 and 2006 seasons, respectively.

Table (21): Effect of the interaction between planting dates and boron fertilization (A x C) on fiber properties of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Treatments		Fiber length 2.5 % SL	Fiber length 50 % SL	Uniformity ratio %	Pressley index	Micronaire reading
2005 season						
A1	C1	30.94	25.59	82.87	8.89	4.54
	C2	31.14	25.93	83.28	8.89	4.62
	C3	31.48	26.31	83.71	8.73	4.38
A2	C1	31.78	26.21	83.10	8.91	4.60
	C2	31.31	26.09	83.37	9.51	4.49
	C3	31.24	25.66	83.49	9.99	4.61
L.S.D. at 0.05		**0.81**	**N.S.**	**N.S.**	**0.50**	**0.23**
2006 season						
A1	C1	31.03	25.92	83.50	9.73	4.92
	C2	31.20	26.12	83.74	9.58	5.03
	C3	31.57	26.30	83.66	9.59	5.03
A2	C1	31.91	26.57	83.26	10.18	4.73
	C2	31.40	26.21	83.44	9.88	4.74
	C3	31.32	26.17	83.50	9.87	4.87
L.S.D. at 0.05		**0.82**	**N.S.**	**N.S.**	**0.52**	**0.17**

A1 : Early planting at 15 March.
A2: Late planting at 15 April.
C1: Without boric acid.
C2: 700 gm / fed boric acid.
C3: 1400 gm / fed boric acid.

From Table (21), it could be observed that fiber length at 50 % SL and length uniformity ratio were not affected by the interaction.

2. *Fiber strength (Pressley index)*

With reference to the results in Table (21), the interaction between planting dates x boron fertilizer (A x C) show significant effects on fiber strength (Pressley index) in both seasons. The highest value (9.99) was obtained from the late planting date and applying 1400 gm / fed boric acid. While, the lowest value (8.73) was obtained from the early planting date and applying 1400 gm / fed boric acid in the first season. In the second season, the highest value (10.18) was obtained from the late planting date and zero boron. However, the lowest value (9.37) was recorded for the early planting date and zero boron.

3. *Fiber fineness (micronaire reading)*

Planting dates x boron fertilizer interaction exhibited significant effects on micronaire reading in both seasons (Table, 21). The highest value of micronaire reading (4.62 micronaire unit) was obtained from the early planting date and applying 700 gm / fed boric acid. Whereas, the lowest value of micronaire reading (4.38 micronaire unit) was recorded for the early planting date and applying 1400 gm / fed boric acid in the first season. In the second season, the highest value of micronaire reading (5.03 micronaire unit) was obtained from the early planting date and applying 700 gm / fed boric acid or 1400 gm / fed boric acid. Meanwhile, the lowest value of micronaire reading (4.73 micronaire unit) was obtained from the late planting date and without boron addition.

c. Effect of the interaction between potassium and boron fertilization (B x C) on:

1. *Fiber length parameters*

As shown in Table (22), the differences in 2.5 % SL. fiber length as affected by potassium and boron fertilizer interaction (B x C) was significant in both seasons. The highest values (31.90 and 31.98 mm) were recorded for spraying with 2.4 kg K_2O / fed twice at squaring and flowering stages and applying 700 gm / fed boric acid. While, the lowest values (30.75 and 30.87 mm) were obtained from applying 24 kg K_2O / fed as soil application after thinning + spraying with 2.4 kg K_2O / fed at flowering stage and applying 700 gm / fed boric acid in 2005 and 2006 seasons, respectively. It is also clear that, the differences in fiber length at 50 % SL. were significant in both seasons. The highest values (26.70 and 26.84 mm) were obtained from applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid. While the lowest values (25.37 and 25.64) were obtained from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid in 2005 and 2006 seasons, respectively. Nevertheless, the differences in fiber length uniformity ratio were significant in the first season only. The highest value (83.82 %) was obtained from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 1400 gm / fed boric acid. Meanwhile, the lowest value (82.55 %) was obtained from applying 24 kg K_2O / fed as soil application after

Table (22): Effect of the interaction between potassium and boron fertilization (B x C) on fiber properties of cotton plant (Giza 80) in 2005 and 2006 seasons.

Characters / Treatments		Fiber length 2.5 % SL	Fiber length 50 % SL	Uniformity ratio	Pressley index	Micronaire reading
2005 season						
B1	**C1**	31.33	25.88	82.68	9.00	4.53
	C2	31.03	25.97	83.78	8.87	4.48
	C3	31.13	25.63	83.80	9.60	4.30
B2	**C1**	30.97	25.58	83.27	8.82	4.52
	C2	30.75	25.37	82.55	9.08	4.47
	C3	31.32	26.03	83.82	8.90	4.77
B3	**C1**	31.78	26.23	83.00	8.88	4.67
	C2	31.90	26.70	83.63	9.65	4.72
	C3	31.63	26.28	83.18	9.58	4.42
L.S.D. at 0.05		**0.99**	**1.13**	**1.22**	**0.61**	**0.29**
2006 season						
B1	**C1**	31.53	26.26	83.25	9.75	4.85
	C2	31.05	26.03	83.82	9.73	4.83
	C3	31.27	26.04	83.73	9.47	4.87
B2	**C1**	31.07	25.91	83.42	9.62	4.80
	C2	30.87	25.64	83.07	9.43	4.83
	C3	31.32	26.23	83.75	9.80	4.95
B3	**C1**	31.82	26.56	83.47	9.95	4.83
	C2	31.98	26.84	83.90	10.02	5.00
	C3	31.75	26.43	83.25	9.87	5.03
L.S.D. at 0.05		**1.01**	**1.20**	**N.S.**	**N.S.**	**0.21**

B1: 24 kg K_2O/fed as soil application after thinning.

B2: 24 kg K_2O/fed as soil application after thinning + 2.4 kg K_2O/fed spray at flowering stage.

B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage.

C1: Without boric acid.

C2: 700 gm / fed boric acid.

C3: 1400 gm / fed boric acid.

thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid.

2. *Fiber strength (Pressley index)*

With reference to Table (22), the differences (Pressley index) as affected by potassium and boron fertilizers interaction (B x C) were significant in the first season only. The highest value (9.65) was obtained from applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid. On the other hand, the lowest value (8.82) was reported from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and zero boron.

3. *Fiber fineness (micronaire reading)*

As shown in Table (22), the differences in fiber fineness as affected by potassium and boron fertilizers interaction (B x C) were significant in both seasons. The highest micronaire reading resulted from applying 24 kg K_2O / fed as soil application after thinning + spraying with 2.4 kg K_2O / fed at flowering stage and applying 1400 gm / fed boric acid. On the other hand, the lowest micronaire reading was obtained from 24 kg K_2O / fed as soil application after thinning and 1400 gm / fed boric acid in the first season. In the second season, the highest micronaire reading (5.03 micronaire unit) was noticed for spraying with 2.4 kg K_2O / fed twice at squaring and flowering stages and 1400 gm / fed boric acid.

While the lowest micronaire reading (4.80 micronaire unit) was found from 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage without boron.

Results in general suggest that B x C has beneficial effect on cotton plant. Combining boron with potassium as foliar application may be essential for stabilization of cell membrane transport, stimulating hydrogen pumping ATP activation and K^+ uptake (**Albers *et al.*, 2008**). Potassium plays a physiological role in the transformation of sugar and carbohydrate metabolism in plant tissues and in extending seed filling period.

d. Effect of the interaction among planting dates, potassium and boron fertilization (A x B x C) on:

1. *Fiber length parameters*

With reference to Tables (23 and 24), it is evident that the interaction between planting date, potassium and boron fertilizer (A x B x C) had significant effect on 2.5 % SL. fiber length in both seasons. The highest values were obtained from the late planting date, 2.4 kg K_2O / fed sprayed twice at squaring and flowering stages and applying 700 gm / fed boric acid. While, the lowest values were obtained from the late planting date, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed sprayed at flowering stage and applying 700 gm / fed boric acid in 2005 and 2006 seasons, respectively. Nevertheless, (A x B x C) interaction had significant effects on 50 % SL. fiber length in both seasons.

The highest values (27.37 and 27.55 mm) were recorded for the late planting, 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid. However, the lowest values (24.60 and 24.83 mm) were obtained from the late planting date, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and

Table (23): **Effect of the interaction between planting dates, potassium and boron fertilization (A x B x C) on fiber properties of cotton plant (Giza 80) in 2005 season.**

Characters / Treatments			Fiber length 2.5 % SL	Fiber length 50 % SL	Uniformity ratio	Pressley index	Micronaire reading
A1	B1	C1	30.57	25.03	82.00	9.20	4.53
		C2	30.87	25.63	83.20	8.90	4.57
		C3	31.23	26.30	84.33	9.17	4.07
	B2	C1	30.93	25.60	83.00	8.37	4.57
		C2	31.40	26.13	83.37	8.97	4.63
		C3	31.27	26.23	84.07	8.40	4.73
	B3	C1	31.33	26.13	83.60	9.10	4.53
		C2	31.17	26.03	83.27	8.80	4.67
		C3	31.93	26.40	82.73	8.63	4.33
A2	B1	C1	32.10	26.73	83.37	8.80	4.53
		C2	31.20	26.30	84.37	8.83	4.40
		C3	31.03	24.97	83.27	10.03	4.53
	B2	C1	31.00	25.57	83.58	9.27	4.47
		C2	30.10	24.60	81.73	9.20	4.30
		C3	31.37	25.83	83.57	9.40	4.80
	B3	C1	32.23	26.33	82.40	8.67	4.80
		C2	32.63	27.37	84.00	10.50	4.77
		C3	31.33	26.17	83.63	10.53	4.50
L.S.D. at 0.05			**1.40**	**1.59**	**N.S.**	**0.86**	**0.41**

A1: Early planting at 15 March.

A2: Late planting at 15 April.

B1: 24 kg K_2O/fed as soil application after thinning.

B2: 24 kg K_2O/fed as soil application after thinning. + 2.4 kg K_2O/fed spray at flowering stage.

B3: 2.4 kg K_2O/fed as spray at squaring stage +2.4 kg K_2O/fed spray at flowering stage.

C1: Without boric acid.

C2: 700 gm / fed boric acid.

C3: 1400 gm / fed boric acid.

Table (24): **Effect of the interaction between planting dates, potassium and boron fertilization (A x B x C) on fiber properties of cotton plant (Giza 80) in 2006 seasons.**

Characters / Treatments			Fiber length 2.5 % SL	Fiber length 50 % SL	Uniformity ratio	Pressley index	Micronaire reading
A1	B1	C1	30.67	25.45	82.97	9.23	5.00
		C2	30.97	25.80	83.33	9.87	5.00
		C3	31.33	26.08	84.23	9.40	4.87
	B2	C1	31.10	25.89	83.27	9.37	4.83
		C2	31.43	26.45	84.17	9.03	5.13
		C3	31.23	26.17	83.80	9.70	5.07
	B3	C1	31.33	26.41	84.27	9.50	4.93
		C2	31.20	26.12	83.73	9.83	4.97
		C3	31.13	26.64	82.93	9.57	5.17
A2	B1	C1	32.40	27.07	83.53	10.27	4.70
		C2	31.13	26.25	84.30	9.60	4.67
		C3	31.20	26.00	83.23	9.53	4.87
	B2	C1	31.03	25.93	83.47	9.87	4.77
		C2	30.30	24.83	81.97	9.83	4.53
		C3	31.40	26.28	83.70	9.90	4.83
	B3	C1	32.30	26.71	82.67	10.40	4.73
		C2	32.77	27.55	84.07	10.20	5.03
		C3	31.37	26.21	83.57	10.17	4.90
L.S.D. at 0.05			**1.43**	**1.70**	**N.S.**	**0.90**	**0.30**

A1: Early planting at 15 March.
A2: Late planting at 15 April.
B1: 24 kg K_2O/fed as soil application after thinning.
B2: 24 kg K_2O/fed as soil application after thinning. + 2.4 kg K_2O/fed spray at flowering stage.
B3: 2.4 kg K_2O/fed as spray at squaring stage +2.4 kg K_2O/fed spray at flowering stage.
C1: Without boric acid.
C2: 700 gm / fed boric acid
C3: 1400 gm / fed boric acid.

applied 700 gm/fed boric acid in 2005 and 2006 seasons, respectively. It could be noticed from Tables (23 and 24) that, uniformity ratio was not affected by the interaction in both seasons.

2. *Fiber strength (Pressley index)*:

As shown in Tables (23 and 24), the interaction between planting dates, potassium and boron fertilizers had significant effects on (Pressley index) in both seasons. The highest value result from the late planting date, 2.4 kg K_2O / fed sprayed at squaring stage + 2.4 kg K_2O / fed sprayed at flowering stage and applying 1400 gm / fed boric acid. The lowest value (8.37 g / tex) was obtained from the early planting date, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed sprayed at flowering stage and zero boron in the first season. In the second season, the highest value was obtained from the late planting date, 2.4 kg K_2O / fed sprayed twice at squaring and flowering stages and zero boron. Whereas, the lowest value (9.03 g / tex) was obtained from the early planting date, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed sprayed at flowering stage and applying 700 gm / fed boric acid.

3. *Fiber fineness (micronaire reading)*

As shown in Tables (23 and 24), the interaction between planting dates, potassium and boron fertilizers (A x B x C) had significant effect on fiber micronaire reading in both seasons. The highest micronaire reading resulted from the late planting date (15 April), 2.4 kg K_2O / fed spraying twice at squaring and flowering stage and zero boron. However, the lowest micronaire reading (4.07 micronaire unit) was obtained from the early

planting date, 24 kg K_2O / fed as soil application after thinning and applying 1400 gm / fed boric acid in the first season. In the second season, the highest micronaire was observed from the early planting date, 2.4 kg K_2O / fed spraying twice at squaring and flowering stage and applying 1400 gm / fed boric acid. Whereas, the lowest value (4.53 micronaire unite) was obtained from the late planting date (15 April), 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid.

IV. Chemical analysis

i. The chemical analysis of cotton leaves and seeds after 15 days from the last spraying treatment and mature seeds in the second season (2006)

A. Effect of planting dates on:

1. *Chlorophyll (A)*

The results indicate that chlorophyll (A) concentration (as mg / g. dw) of cotton leaves was significantly affected by planting dates (Table 25). The highest value (4.72 mg / g. dw) was noticed from the late planting date, while, the lowest value (3.56 mg / g. dw) was obtained from early planting.

2. *Chlorophyll (B)*

The results indicate that chlorophyll (B) concentration of cotton leaves was significantly affected by planting date. The highest value (3.60 mg / g. dw) was showed from late planting date. While, the lowest value (2.50 mg / g. dw) was obtained from the early planting date.

3. *Total chlorophyll (A +B)*

As shown from Table (25), the results indicated that total chlorophyll concentration of cotton leaves was significantly affected by planting dates. The highest value (8.32 mg / g. dw) was obtained from the late planting date. While, the lowest value (6.06 mg / g. dw) was obtained from the early planting date.

4. *Carotenoids*

The results indicate that carotenoids concentration of cotton leaves was significantly affected by planting date (Table 25). The highest value (0.62 mg / g. dw) was found for the late planting date (15 April). Whereas, the lowest value (0.42 mg / g. dw) was obtained from the early planting date.

5. *Total soluble sugar*

From the same Table (25), it could be seen that, the total soluble sugar in leaves was significantly affected by planting date. The highest value (17.70 mg / g. dw) was obtained from the late planting date. While, the lowest value (17.54 mg / g. dw) was recorded from the early planting date.

6. *Reducing sugars*:

The results in Table (25), indicate that reducing sugars in leaves was significantly affected by planting date. The highest value (7.40 mg / g. dw) was obtained from early planting date. While, the lowest value (7.21 mg / g. dw) was found from the late planting date.

7. *Potassium percentage*

The results in Table (25) indicated that potassium concentration of cotton leaves was significantly affected by

Table (25): Effect of planting dates on some chemical contents of cotton plant (Giza 80) in 2006 season.

Characters / Planting dates (A)	In leaves after 15 days from the last spraying treatments								In mature seeds	
	Chlorophyll A mg / g. dw	Chlorophyll B mg/g. dw	Total Chlorophyll AB mg / g. dw	Carotenoids Content mg / g. dw	Total soluble sugars mg / g. dw	Reducing Sugars mg / g. dw	Potassium %	Boron ppm	Protein %	Oil %
15 March	3.56	2.50	6.06	0.42	17.54	7.21	2.70	10.89	25.00	17.81
15 April	4.72	3.60	8.32	0.62	17.70	7.40	2.80	12.11	25.18	17.46
L.S.D. at 0.05	**0.01**	**0.30**	**0.38**	**0.13**	**0.01**	**0.02**	**0.10**	**0.02**	**N.S.**	**0.21**

planting date. The highest potassium concentration (2.80 %) was obtained from the late planting date, while the lowest value (2.70 %) resulted from the early planting date.

8. *Boron*

The results in Table (25) indicate that planting dates possessed significant effects on boron concentration in the cotton leaf. The highest value (12.11 ppm) was obtained from the late planting date. But, the lowest value (10.89 ppm) was resulted from the early planting date.

ii. In mature seeds:

1. *Protein percentage*

The results in Table (25) show that protein percentage in cotton seeds was not affected by planting dates.

2. *Oil percentage*

The results in Table (25) indicate that oil percentage in seeds was significantly affected by planting date. The highest value (17.81 %) was obtained from the early planting date. But the lowest value (17.46 %) was found from the late planting date. These finding are supported by **Abou El-Nour *et al.* (2000)**.

It is clear that yield of cotton plants is because of many components and each component is affected by many factors such as planting date, potassium and boron fertilization and others. It is evident from the result obtained that cotton plants in this case is prefered to be planted in late planting date suitable climatic conditions which enhance the physiological processes and improve activities of some specific enzymes which enhance the accumulation and composition of these chemical conditions

i.e., (chlorophyll a and b, carotenoids, reducing sugars, potassium % and boron % in leaves, protein and oil percentages in seeds).

B. Effect of potassium fertilization

i. In the leaves after 15 days from the last spraying treatment

1. *Chlorophyll (A)*

Results in Table (26) reveal that chlorophyll (A) was significant affected by palum. The highest value (4.32 mg / g. dw) was reported from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. The lowest value (4.04 mg / g. dw) was achieved by applying 2.4 kg K_2O / fed spraying at squaring stage + 2.4 kg K_2O / fed spraying at flowering stage. These results are in agreement with those reported by **Azab *et al.* (1993)** and **Wahdan *et al.* (1994)** who reported that chlorophyll (A) content of cotton leaves significantly responded to K fertilization.

2. *Chlorophyll (B)*

Result in Table (26) clearly show that chlorophyll (B) content of cotton leaves was not affected by potassium treatments.

3. *Total chlorophyll (A + B)*

From the same Table, results indicated that the total chlorophyll concentration of cotton leaves was significantly affected by potassium fertilizer. The highest value (7.42 mg / g. dw) was obtained from applying 24 kg K_2O / fed after as soil application thinning + 2.4 kg K_2O / fed spraying at flowering stage. However, the lowest value (7.07 mg / g. dw) was showed

Table (26): Effect of potassium fertilization on some chemical contents of cotton plant (Giza 80) in 2006 season.

Characters / Potassium fertilization (K_2O/fed) (B)	In leaves after 15 days from the last spraying treatments								In mature seeds	
	Chlorophyll A mg / g. dw	Chlorophyll B mg/g. dw	Total Chlorophyll AB mg / g. dw	Carotenoids Content mg / g. dw	Total soluble sugars mg / g. dw	Reducing Sugar mg / g. dw	Potassium %	Boron ppm	Protein %	Oil %
24 kg after thinning.	4.07	3.00	7.07	0.39	17.20	6.84	2.70	9.42	24.22	17.16
24 Kg after thinning + 2.4 kg spray at flowering stage.	4.32	3.10	7.42	0.52	18.35	7.79	2.80	10.04	26.04	18.43
2.4 kg spray at squaring stage + 2.4 kg spray at flowering stage.	4.04	3.10	7.14	0.66	17.31	6.98	2.80	15.05	25.00	17.32
L.S.D. at 0.05	0.23	N.S.	0.36	0.04	0.12	0.24	0.10	0.03	0.38	1.02

from applying 24 kg K_2O / fed after thinning. These results are in harmony with those obtained by **Azab *et al.* (1993)** and **Wahdan *et al.* (1994),**who reported that total chlorophyll content of cotton leaves significantly responded to potassium fertilization.

4. *Carotenoids*

Results in Table (26), show that carotenoids concentration of cotton leaves was significantly affected by potassium fertilizer. The highest value (0.66 mg / g. dw) was recorded for applying 2.4 kgK_2O / fed spray twice at squaring and flowering stages. While, the lowest value (0.39 mg / g. dw) was obtained from applying 24 kg K_2O / fed as soil application after thinning.

5. *Total soluble sugar*

The results in Table (26) indicate that total soluble sugar in leaves was significantly affected by potassium fertilizer. The highest value (18.35 mg / g. dw) was found for applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stages. However, the lowest value (17.20 mg / g. dw) was obtained for applying 24 kg K_2O / fed as soil application after thinning. The results are in agreement with those recorded by **Azab *et al.* (1993), Wahdan *et al.* (1994)** and **Ghourab *et al.* (2000)**.

6. *Reducing sugars*:

The results indicate that reducing sugars in leaves was significantly affected by potassium fertilizer (Table, 26). The highest value (7.79 mg / g. dw) was recorded from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While the lowest value (6.84 mg / g.

dw) was noticed from applying 24 kg K_2O / fed as soil application after thinning. Similar conclusions were reported by **Azab *et al.* (1993) and Wahdan *et al.* (1994)**, who found that reducing sugars content of cotton leaves increased by potassium fertilization.

7. *Potassium percentage*

Table (26) revealed that potassium was significantly increased in cotton leaves. The highest value (2.80 %) was observed from applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage or 2.4 kg spray twice at squaring and flowering stages. While, the lowest value (2.70 %) was obtained from applying 24 kg K_2O / fed after thinning as soil application. **Azab *et al.* (1993)** found that potassium application after thinning increased in potassium contents in cotton leaves compared with control.

8. *Boron content*

Boron concentration in leaves as shown in Table (26), that potassium fertilizer had significant effects on boron concentration in leaves. The highest value (15.05 ppm) was obtained from applying 2.4 kg spray twice at squaring and flowering stage. While the lowest value, (9.42 ppm) was recorded for applying 24 kg K_2O / fed as soil application after thinning.

ii. In mature seeds:

1. *Protein percentage*

The results in Table (26), indicate that protein percentage in seeds was significantly affected by potassium fertilizer in 2006

season. The highest value was obtained from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O spraying at flowering stage. While, the lowest value (24.22 %) was noticed for applying 24 kg K_2O / fed as soil application after thinning. These results are in harmony with those mentioned by **Abou El-Nour *et al.* (2000), Abd El-Shafy *et al.* (2001), Sawan *et al.* (2006 b)** and **Sawan *et. al.* (2007).** Who found that protein percentage in seeds increased by potassium application.

2. *Oil percentage in seeds*

Results in Table (26) reveal that oil percentage in seeds was significantly affected by potassium fertilizer. The highest value (18.43 %) was obtained from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O spraying at squaring stage. Meanwhile, the lowest value (17.16 %) was recorded from applying 24 kg K_2O / fed after thinning. These results are in general agreement with those obtained by **Azab *et al.* (1993), Abou El-Nour *et al.* (2000), Abd El-Shafy *et al.* (2001), Sawan *et al.* (2006 a)** and **Sawan *et al.* (2007),** who reported that oil percentage in seeds increased by potassium fertilization. Potassium plays an important role in the physiological processes during formation and maturation period also mainly expressed in carbohydrate metabolism and translocation of metabolites. Also, potassium has favorable effects on the metabolism of nucleic acids, proteins and vitamins (**Bisson *et al.*, 1994 and Bendnorz and Oasterhuis, 1999)** may be elevate carbohydrate concentration in source tissues (e.g., leaves). Increasing oil and protein contents in seeds may be attributed to the role of K on some biochemical pathways in plants. (**Pettigrew, 1999**).

C. Effect of boron fertilization

i. In the leaves

1. *Chlorophyll (A)*

Results in Table (27) illustrate that boron fertilizer had significant effect on chlorophyll (A) of cotton leaves. The highest value (4.37 mg / g. dw) was observed from applying 700 gm / fed boric acid. Whereas, the lowest value (3.82 mg / g. dw) was obtained with zero boron fertilization. These results are in the same line with those reported by **Saeed (2000).**

2. *Chlorophyll (B)*

Results in Table (27) reveal that boron fertilizer had significant effect in chlorophyll (B) content of cotton leaves. The highest value (3.20 mg / g. dw) was obtained from applying 1400 gm / fed boric acid. However, the lowest value (2.80 mg / g. dw) was found from unfertilized by boric acid. Similar results were obtained by **Saeed (2000)** who reported that boron application increased chlorophyll (B) contents of cotton leaves.

3. *Total chlorophyll*

Results in Table (27) reveal that boron fertilizer had significant effect on total chlorophyll of cotton leaves. The highest value (7.47 mg / g. dw) was obtained from applying 1400 gm / fed boric acid. The lowest value (6.62 mg / g. dw) resulted from zero boron. These results are confirmed by **Saeed (2000).**

4. *Carotenoids*

With references to Table (27), it is evident that carotenoids were significantly affected by boron fertilizer. The highest value

Table (27): Effect of boron fertilization on some chemical contents of cotton plant (Giza 80) in 2006 season.

Characters / Boron fertilizer gm / fed as boric acid (C)	In leaves after 15 days from the last spraying treatments								In mature seeds	
	Chlorophyll A mg / g. dw	Chlorophyll B mg/g. dw	Total Chlorophyll AB mg / g. dw	Carotenoids Content mg / g. dw	Total soluble sugars mg / g. dw	Reducing Sugars mg / g. dw	Potassium %	Boron ppm	Protein %	Oil %
Without boron	3.82	2.80	6.62	0.48	17.58	7.12	2.70	7.55	23.18	17.34
700 g / fed boric acid	4.37	3.10	7.47	0.54	17.68	7.28	2.90	12.54	26.82	18.01
1400 g / fed boric acid	4.23	3.20	7.43	0.54	17.60	7.22	2.70	14.42	25.26	17.56
L.S.D. at 0.05	**0.14**	**0.10**	**0.25**	**0.02**	**0.10**	**0.13**	**0.20**	**0.06**	**0.79**	**N.S.**

(0.54 mg / g. dw) resulted from applying 700 gm / fed or 1400 gm / fed boric acid. However, the lowest value (0.48 mg / g. dw) was obtained from zero boron fertilizer.

5. *Total soluble sugar*

The effect of boron fertilizer, as shown in Table (27), indicate that total soluble sugar was significantly affected by boron fertilizer. The highest value (17.68 mg / g. dw) was noticed from applying 700 gm / fed boric acid. While, the lowest value (17.58 mg / g. dw) was obtained from zero level of boron. These results are in line with those reported by **Saeed (2000)**.

6. *Reducing sugars*

Regard in the effect of boron fertilizer, results in Table (27) reveal that reducing sugars in leaves was significantly increased in reducing sugars. The highest value (7.28 mg / g. dw) was obtained from applying 700 gm / fed boric acid. However, the lowest value (7.12 mg / g. dw) was found from zero boron. These results are in agreement with those reported by **Saeed (2000).**

7. *Potassium percentage*

The effect of boron fertilizer on this trait, results in Table (27) reveal that, boron possessed significant effect on potassium concentration of cotton leaves. The highest value (2.90 %) was obtained from applying 700 g / fed boric acid. However, the lowest value (2.70 %) was showed from zero or 1400 gm / fed boric acid. In this respect **Ahmed *et al.* (1992)**, **Omran *et al.* (1999)** and **Saeed (2000)** reported that spray cotton plants with boron increased potassium contents in cotton leaves.

8. *Boron*

Boron fertilizer had significant effects on boron concentration of leaves. The highest value (14.42 ppm) was obtained from applying 1400 gm / fed boric acid. On the other hand, the lowest value (7.55 ppm) was noticed with zero boron.

ii. In mature seeds:

1. *Protein percentage*

Results in Table (27) show that protein percentage in seeds was significantly affected by boron fertilizer in 2006 season. The highest value (26.82 %) was obtained from applying 700 gm / fed boric acid. While, the lowest value (23.18 %) was shown from zero boric acid. These results are in good line with those reviewed by **Ahmed *et al.* (1992)** and **Saeed (2000)**.

2. *Oil percentage*

The results in Table (27) illustrate that oil percentage in cotton seeds was not affected by boron treatments.

Boron plays an essential role in plant in converting nitrogen and carbohydrates into protein. Also, boron primarily regulates the carbohydrate metabolism in plants. It is essential for protein synthesis, and sugar translocation in cotton seeds. **Parr and Loughman (1983)** postulated that boron is involved in a number of metabolic pathways (sugar transport, respiration, carbohydrate, RNA, ATP and phenol metabolism. **Ahmed (1977)** reported that boron application caused an increase in chlorophyll of cotton leaves. While, **Ahmed *et al.* (1992)** found that spraying cotton plants with boron at flowering stage increased total carbohydrate contents in leaves, potassium

contents in cotton leaves, protein contents and oil contents in cotton seeds.

D. Effect of the interaction

a. Effect of the interaction between planting dates and potassium fertilization (A x B) on chemical contents.

i. In the leaves

1. *Chlorophyll (A)*

Results in Table (28) illustrate that, interaction between planting dates x potassium fertilizer (A x B), exhibited significant effect on chlorophyll (A) content of cotton leaves. The highest value (5.15 mg / g. dw) was obtained from the late planting date and applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While, the lowest value (3.48 mg / g. dw) was recorded for the early planting date and applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage.

2. *Chlorophyll (B)*

With reference to Table (28), it could be seen that the interaction between planting date and potassium fertilizer (A x B), exhibited significant effects on chlorophyll (B) concentration of leaves. The highest value (3.70 mg / g. dw) was recorded from the late planting date and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. Whereas, the lowest value (2.05 mg / g. dw) was obtained from the early planting date and applying 24 kg K_2O / fed after thinning.

Table (28): Effect of the interaction between planting dates and potassium fertilization (A x B) on chemical analysis of cotton plant (Giza 80) in 2006 season.

Characters / Treatments		In leaves after 15 days from the last spraying treatments								In mature seeds	
		Chlorophyll A mg / g. dw	Chlorophyll B mg / g. dw	Total Chlorophyll AB mg / g. dw	Carotenoids Content mg / g. dw	Total soluble sugars mg / g. dw	Reducing sugars mg/g dw	Potassium %	Boron ppm	Protein %	Oil %
A1	B1	3.59	2. 05	5.64	0.28	17.10	6.85	2.60	7.92	23.44	16.61
	B2	3.48	2.40	5.88	0.48	18.33	7.67	2.80	9.83	26.04	18.79
	B3	3.62	2.70	6.32	0.52	17.19	7.13	2.70	14.92	25.62	18.02
A2	B1	4.55	3.40	7.95	0.31	17.30	6.83	2.70	10.25	25.00	17.71
	B2	5.15	3.70	8.85	0.76	18.37	7.51	2.80	10.92	25.04	18.07
	B3	4.46	3.50	7.96	0.80	17.42	7.84	2.90	15.17	24.48	16.64
L.S.D. at 0.05		**0.32**	**0.25**	**0.52**	**0.06**	**0.25**	**0.32**	**0.30**	**0.03**	**0.54**	**1.44**

A1 : Early planting at 15 March.

A2: Late planting at 15 April.

B1: 24 kg K_2O/fed as soil application after thinning.

B2: 24 kg K_2O/fed as soil application after thinning + 2.4 kg K_2O/fed spray at flowering stage..

B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage

3. *Total chlorophyll (A + B)*

Planting date x potassium fertilizer interaction (A x B) exhibited significant effect on total chlorophyll concentration of cotton leaves (Table, 28). The highest value (8.85 mg / g. dw) was obtained from the late planting date and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While, the lowest value (5.64 mg / g. dw) was observed from the early planting date and applying 24 kg K_2O / fed as soil application after thinning.

4. *Carotenoids*

As shown in Table (28), the interaction between planting date x potassium fertilizer exhibited significant effects on carotenoids of leaves. The highest value (0.80 mg / g. dw) was obtained from the late planting date and applying 2.4 kg K_2O / fed spraying twice. The lowest value (0.28 mg / g. dw) was noticed for the early planting date and applying 24 kg K_2O / fed after thinning.

5. *Total soluble sugar*

Planting dates x potassium interaction exhibited significant effects on total soluble sugar (Table, 28). The highest value (18.37 mg / g. dw) was obtained from the late planting date and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While, the lowest value (17.10 mg / g. dw) was recorded from the early planting date and applying 24 kg K_2O / fed as soil application after thinning.

6. *Reducing sugars*

The interaction between planting dates x potassium exhibited significant effects on reducing sugars in leaves. The highest value (7.84 mg / g. dw) was observed for the late planting date and applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages. While, the lowest value (6.83 mg/g. dw) was obtained from the late planting date and applying 24 kg K_2O / fed as soil application after thinning. These results are in accordance with those reviewed by **Saeed (2000).**

7. *Potassium percentage*

Results tabulated in Table (28) indicate that, planting dates x potassium (A x B) interaction exhibited significant effects on potassium concentration of leaves. The highest value (2.90 %) was obtained from the late planting date and applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages. However, the lowest value (2.60 %) was shown for the early planting date and applying 24 kg K_2O / fed as soil application after thinning.

8. *Boron*

The effect of the interaction between planting dates and potassium on boron content of leaves was significant (Table 28). The highest value (15.17 ppm) was obtained from the late planting date and applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages. However, the lowest value (7.92 ppm) was obtained when planting date and applying 24 kg K_2O / fed as soil application after thinning.

ii. In mature seeds:

1. *Protein percentage*

Results presented in Table (28) indicate that, the interaction between planting date x potassium exhibited significant effects on protein percentage of seeds. The highest value (26.04 %) was obtained from both early and late planting and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While, the lowest value (23.44 %) was obtained from the early planting date and applying 24 kg K_2O / fed after thinning.

2. *Oil percentage*

Table (28) showed that, the interaction between planting date and potassium exhibited significant effects on oil percentage of seeds. The highest value (18.79 %) was obtained from the early planting date and applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage. While the lowest value (16.61) was recorded from the early planting date and applying 24 kg K_2O / fed after thinning.

b. Effect of the interaction between planting dates and boron fertilizer (A x C) on:

i. In the leaves after 15 days from the last spraying treatment

1. *Chlorophyll (A)*

It is evident from Table (29) that, planting date x boron fertilizer interaction exhibited significant effects on chlorophyll (A) of cotton leaves. The highest value (4.84 mg / g. dw) was noticed from the late planting date and 700 gm / fed boric acid.

Table (29): Effect of the interaction between planting dates and boron fertilization (A x C) on some chemical contents of cotton plant (Giza 80) in 2006 season.

Characters / Treatments		In leaves after 15 days from the last spraying treatments								In mature seeds	
		Chlorophyll A mg / g. dw	Chlorophyll B Mg / g. dw	Total Chlorophyll AB mg / g. dw	Carotenoids Content mg / g. dw	Total soluble sugars Mg/g. dw	Reducing Sugars mg/g. dw	Potassium %	Boron ppm	Protein %	Oil %
A1	C1	3.07	2.20	5.27	0.58	17.50	7.17	2.60	6.83	22.92	16.90
	C2	3.91	2.60	5.51	0.62	17.92	7.24	2.70	9.00	22.52	17.99
	C3	3.72	2.70	6.42	0.65	17.60	7.23	2.80	16.83	28.56	18.53
A2	C1	4.58	3.40	7.98	037	17.58	7.07	2.70	8.25	22.44	17.77
	C2	4.84	3.50	8.34	0.46	17.45	7.31	2.80	16.08	28.13	18.03
	C3	4.74	3.80	8.54	0.43	17.59	7.20	2.90	12.00	24.96	16.59
L.S.D. at 0.05		**0.20**	**0.20**	**0.36**	**0.03**	**0.17**	**0.22**	**0.25**	**0.06**	**1.11**	**1.05**

A1 : Early planting at 15 March.
A2: Late planting at 15 April.
C1: Without boric acid.
C2: 700 gm / fed boric acid.
C3: 1400 gm / fed boric acid.

While, the lowest value (3.07 mg / g. dw) was obtained from the early planting date and zero boron.

2. *Chlorophyll (B)*

Planting dates x boron interaction as shown in Table (29) exhibited significant effects on chlorophyll (B) concentration of leaves. The highest value (3.80 mg / g. dw) was obtained from the late planting date and 1400 gm / fed boric acid. While, the lowest value (2.20 mg / g. dw) resulted from the early planting date and zero boron.

3. *Total chlorophyll (A + B)*

The interaction between planting dates and boron showed significant effects on total chlorophyll concentration of cotton leaves (Table, 29). The highest value (8.54mg / g. dw) was obtained from late planting date and 1400 gm / fed as boric acid. On the other side, the lowest value (5.27 mg / g. dw) was recorded for the early planting date and zero boron.

4. *Carotenoids*

Planting date and boron interaction (A x C) as shown in Table (29) exhibited significant effects on carotenoids of cotton leaves. The highest value (0.65 mg / g. dw) was obtained from the early planting date and applying 1400 gm / fed boric acid. While, the lowest value (0.37 mg / g. dw) was noticed for the late planting with zero boron.

5. *Total soluble sugar*

The interaction between planting dates and boron exhibited significant effects on total soluble sugar in leaves (Table, 29). The highest value (17.92 mg / g. dw) was obtained from the

early planting date and applying 700 gm / fed boric acid. While, the lowest value was obtained from the late planting date and applying 700 gm / fed boric acid.

6. *Reducing sugars*

Table (29) show that, planting date and boron fertilizer interaction, exhibited significant effects on reducing sugars in leaves. The highest value (7.31 mg / g. dw) was found from the late planting date and applying 700 gm / fed boric acid. However, the lowest value (7.07 mg / g. dw) was noticed from the late planting date and zero boron.

7. *Potassium percentage*

Table (29) illustrate that, planting date x boron fertilizer interaction (A x C) exhibited significant effects on potassium concentration of cotton leaves. The highest value (2.90 %) was obtained from the late planting date on and applying 1400 gm / fed boric acid. On the other side, the lowest value (2.60 %) was recorded from the early planting in absence of boron fertilizer.

8. *Boron*

The effect of the interaction between planting dates and boron fertilizer on boron content in leaves was significant (Table, 29). The highest value (16.83 ppm) was obtained from the early planting date and applying 1400 gm / fed boric acid. While, the lowest value was found from the early planting date with zero boron.

ii. In mature seeds:

1. *Protein percentage*

Planting date and boron fertilizer interaction (A x C) (Table 29), exhibited significant effect on protein percentage in seeds. The highest value was obtained from the early planting date and 1400 gm / fed boric acid. On the other hand, the lowest value was found from the late planting date and zero boron.

2. *Oil percentage*

The interaction between planting date x boron fertilizer (A xC) showed significant effects on oil percentage in seeds (Table 29). The highest value (18.53 %) was obtained from the early planting (15 March) and applying 1400 gm / fed boric acid. The lowest value was found from the late planting date and applying 1400 gm / fed boric acid.

c. Effect of the interaction between potassium and boron fertilization (B x C) on chemical contents

i. In the leaves

1. *Chlorophyll (A)*

As shown in Table (30), the differences in chlorophyll (A) of cotton leaves as affected by potassium and boron fertilizer interaction (B x C) were significant. The highest value was obtained from applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying zero boron. While, the lowest value was found from applying 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid.

Table (30): Effect of the interaction between potassium and boron fertilization (B x C) on some chemical contents of cotton plant (Giza 80) in 2006 season.

Characters / Treatments		In leaves after 15 days from the last spraying treatments								In mature seeds	
		Chlorophyll A mg/g. dw	Chlorophyll B mg/g. dw	Total Chlorophyll AB mg / g. dw	Carotenoids Content mg / g. dw	Total soluble sugars mg/ g. dw	Reducing Sugars mg/ g. dw	Potassium %	Boron ppm	Protein %	Oil %
B1	C1	4.36	3.10	7.46	0.70	17.00	6.75	3.00	9.38	29.69	16.44
	C2	3.45	2.30	5.75	0.58	17.30	6.80	2.50	16.50	22.66	17.18
	C3	4.40	3.40	7.80	0.70	17.30	6.97	2.90	19.25	25.78	17.88
B2	C1	4.78	3.30	8.08	0.35	18.45	7.75	3.20	10.63	24.22	17.92
	C2	3.67	2.70	6.37	0.71	18.55	7.94	2.60	8.38	21.10	17.70
	C3	4.49	3.30	7.79	0.50	18.05	7.69	2.50	11.13	27.33	16.33
B3	C1	3.98	3.00	6.98	0.39	17.28	6.85	2.50	12.63	26.56	17.64
	C2	4.34	3.30	7.64	0.35	17.20	7.01	3.00	12.75	25.78	19.18
	C3	3.79	3.00	6.79	0.43	17.44	7.00	2.60	12.88	22.66	18.46
L.S.D. at 0.05		**0.25**	**0.20**	**0.44**	**0.04**	**0.16**	**0.26**	**0.30**	**0.09**	**1.36**	**1.28**

B1: 24 kg K_2O/fed as soil application after thinning.
B2: 24 kg K_2O/fed as soil application after thinning + 2.4 kg K_2O/fed spray at flowering stage.
B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage.
C1: Without boric acid.
C2: 700 gm / fed boric acid.
C3: 1400 gm / fed boric acid.

2. *Chlorophyll (B)*

Table (30) show that, the differences in chlorophyll (B) content of leaves as the interaction (B x C) were significant. The highest value (3.40 mg / g. dw) was obtained from applying 24 kg K_2O / fed after thinning and applying 1400 g / fed boric acid. Meanwhile, the lowest value was recorded from applying 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid.

3. *Total chlorophyll (A + B)*

The interaction between potassium and boron fertilizer as shown in Table (30) produced significant effect in total chlorophyll content of leaves. The highest value was obtained from applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and no boron fertilizer. In the other side, the lowest value (5.75 mg / g. dw) was recorded from applying 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid.

4. *Carotenoids*

From the same Table (30), it could be seen that potassium x boron fertilizer interaction exhibited significant effects on carotenoids of leaves. The highest value was recorded from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid. The lowest value was obtained from applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying twice and applying 700 gm / fed boric acid.

5. *Total soluble sugar*:

Results in Table (30) illustrated that, total soluble sugar in leaves as affected by potassium and boron fertilizers interaction were significant. The highest value was found from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid. While, the lowest value (17.00 mg / g. dw) was noticed from applying 24 kg K_2O / fed as soil application after thinning and without boron.

6. *Reducing sugars*:

As shown in Table (30), in reducing sugars in leaves as affected by the interaction between potassium and boron fertilizer were significant. The highest value was obtained from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and 700 gm / fed boric acid. Whereas, the lowest value was recorded from applying 24 kg K_2O / fed as soil application after thinning and zero level of boric acid.

7. *Potassium percentage*

As shown in Table (30) it is evident that, potassium and boron interaction (B x C) had significant effects on potassium concentration of cotton leaves. The highest value (3.20 %) was obtained from applying 24 kg K_2O / fed a as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage with zero boron. While, the lowest value was recorded from applying B1C2, B2C3 and B3C1treatments

8. *Boron*

The interaction between potassium and boron fertilizer showed significant effects on boron content in leaves (Table, 30). The highest value (19.25 ppm) was obtained from applying 24 kg K_2O / fed after thinning and 1400 gm / fed boric acid. While, the lowest value was showed from applying 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid.

ii. In mature seeds:

1. *Protein percentage*

With reference to Table (30), it is evident that protein percentage in seeds was significantly affected by potassium and boron fertilizer interaction. The highest value was obtained from applying 24 kg K_2O / fed after thinning and with zero boric acid fertilization. Whereas, the lowest value was recorded for applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid.

2. *Oil percentage*

Table (30) show that, oil percentages in seeds as affected by potassium and boron fertilizer interaction were significant. The highest value was obtained from applying 2.4 kg K_2O / fed spraying at squaring stage + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid. Otherwise, the lowest value was obtained from applying 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 1400 gm / fed boric acid. The interaction between potassium and boron fertilization increased chlorophyll A, B, carotenoids, reducing sugars, total soluble sugars, potassium and

boron contents in leaves as well as protein and oil contents in seeds. The increase of chemical properties could be attributed to stimulating effect on the division and the elongation in the cells of new growth formed especially in apical meristems, consequently increasing the plant height, hormones levels in plant tissues especially IAA and GA contents.

d. Effect of the interaction among planting dates, potassium and boron fertilization (A x B x C) on chemical contents.

i. In the leaves

1. *Chlorophyll (A)*

With reference to Table (31), it could be seen that, (A x (B x C) had significant effects on chlorophyll (A) concentration of leaves. The highest value was obtained from late planting date, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and without boron. Whereas, the lowest value was recorded from the early planting date, 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid.

2. *Chlorophyll (B)*

From Table (31), it is evident that, (A x B x C), had significant effects on chlorophyll (B) concentration of cotton leaves. The highest value was obtained from the late planting date, 2.4 kg K_2O / fed spraying twice and applying 700 gm / fed boric acid. While, the lowest value (1.80 mg / g. dw) was found from the early planting date, 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid.

Table (31): Effect of the interaction between planting dates, potassium and boron fertilization (A x B x C) on some chemical contents of cotton plant (Giza 80) in 2006 season.

Characters / Treatments			In the leaves after 15 days from the last spraying treatment								In mature seeds	
			Chlorophyll A mg / g. dw	Chlorophyll B mg/g. dw	Total Chlorophyll (AB) mg / g. dw	Carotenoids Content mg / g. dw	Total soluble sugars mg / g. dw	Reducing Sugars mg / g. dw	Potassium %	Boron ppm	Protein %	Oil %
A1	B1	C1	4.14	2.80	6.94	0.77	17.10	6.90	3.20	9.75	28.13	15.41
		C2	2.62	1.80	4.42	0.73	17.60	6.65	3.10	15.75	23.44	16.19
		C3	4.01	3.00	7.01	0.89	17.20	7.00	2.40	19.25	26.56	18.22
	B2	C1	3.81	2.60	6.41	0.66	18.20	7.60	3.10	7.75	21.88	18.51
		C2	2.80	2.00	4.80	0.88	18.90	7.90	2.70	6.50	20.31	18.29
		C3	3.83	2.60	6.41	0.73	18.00	7.50	2.60	15.25	28.13	17.27
	B3	C1	3.77	2.90	6.67	0.32	17.20	7.00	2.20	3.00	26.56	16.78
		C2	3.78	2.70	6.48	0.25	17.45	7.18	3.10	4.75	25.00	19.50
		C3	3.31	2.40	5.71	0.34	17.60	7.20	2.60	16.00	25.00	20.10
A2	B1	C1	4.57	3.40	7.97	0.62	16.90	6.60	2.70	9.00	31.25	17.48
		C2	4.28	2.90	7.18	0.42	17.00	6.95	1.90	17.25	21.88	18.10
		C3	4.79	3.90	8.69	0.52	17.40	6.95	3.40	19.25	25.00	17.54
	B2	C1	5.76	3.90	9.66	0.37	18.50	7.90	3.40	13.50	26.56	17.32
		C2	4.54	3.40	7.94	0.53	18.40	7.98	2.40	10.25	21.88	17.11
		C3	5.16	3.90	9.06	0.26	18.10	7.87	2.40	7.00	26.56	15.40
	B3	C1	4.20	3.10	7.30	0.46	17.35	6.70	2.70	2.25	26.56	18.51
		C2	4.91	4.00	8.91	0.44	16.95	7.00	2.90	20.75	26.56	18.87
		C3	4.26	3.50	7.76	0.52	17.28	6.80	2.70	9.75	20.31	16.82
L.S.D. at 0.05			**0.35**	**0.30**	**0.62**	**0.05**	**0.29**	**0.37**	**0.40**	**0.12**	**1.93**	**1.80**

A1: Early planting at 15 March.
A2: Late planting at 15 April.
C1: Without boric acid.
C2: 700 gm / fed boric acid.
C3: 1400 gm / fed boric acid.

B1: 24 kg K_2O/fed as soil application after thinning.
B2: 24 kg K_2O/fed as soil application after thinning. + 2.4 kg K_2O/fed spray at flowering stage.
B3: 2.4 kg K_2O/fed as spray at squaring stage + 2.4 kg K_2O/fed spray at flowering stage.

3. *Total chlorophyll (A + B)*

Table (31), illustrate that, the interaction (A x B x C) had significant effects on total chlorophyll concentration of leaves. The highest value was obtained from the late planting date, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed at flowering stage and zero boron. While, the lowest value was found from the early planting date, 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid.

4. *Carotenoids*

As shown in Table (31), the interaction (A x B x C) had significant effects on carotenoids of leaves. The highest value (0.89 mg / g. dw) was showed from the early planting date, 24 kg K_2O / fed after thinning and applying 1400 gm / fed boric acid. However, the lowest value was obtained from the early planting date, 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid.

5. *Total soluble sugar*:

The results in Table (31) reveal that the three way interaction had significant effect on total soluble sugars in leaves. The highest value was obtained from the early planting date, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid. Whereas, the lowest value (16.90 mg / g. dw) was obtained from the late planting date, 24 kg K_2O / fed as soil application after thinning and zero boron.

6. *Reducing sugars*:

From Table (31), it could be seen that the interaction had significant effects on reducing sugars in leaves. The highest value was obtained from the late planting date, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 700 gm / fed boric acid. Where, the lowest value was found from late planting date, 24 kg K_2O / fed as soil application after thinning and zero boron.

7. *Potassium content*

Regarding to Table (31), it could be seen that, the interaction (A x B x C) had significant effects on potassium concentration leaves. The highest value was obtained from late planting date, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and zero boric acid or late planting date, 24 kg K_2O / fed after thinning and 1400 gm / fed boric acid. While, the lowest value was noticed from the late planting date, 24 kg K_2O / fed after thinning and applying 700 gm / fed boric acid.

8. *Boron*

(A x B x C) interaction had a significant effect on boron content in leaves (Table, 31). The highest value was obtained from the late planting dates and applying 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 700 gm / fed boric acid. However, the lowest value was showed from the late planting date and applying 2.4 kg K_2O / fed spraying twice and zero boron.

ii. In mature seeds:

1. *Protein percentage*

Results tabulated in Table (31) illustrate that interaction among planting dates, potassium and boron fertilizer had significant effects on protein percentage in seeds. The highest value was resulted from late planting date, 24 kg K_2O / fed after thinning without boron. While, the lowest value was obtained from the early planting date, 24 kg K_2O / fed as soil application after thinning + 2.4 kg K_2O / fed and applying 700 gm / fed boric acid or late planting date and applying 2.4 kg K_2O / fed spraying twice and applying 1400 gm / fed boric acid.

9. *Oil percentage*

As shown in Table (31), the interaction among planting date, potassium and boron fertilizer had significant effects on oil percentage in seeds. The highest value was noticed from the early planting date, 2.4 kg K_2O / fed spraying twice at squaring and flowering stages and applying 1400 gm / fed boric acid. While, the lowest value (15.40 %) was resulted from the late planting date, 24 kg K_2O / fed after thinning + 2.4 kg K_2O / fed spraying at flowering stage and applying 1400 gm / fed boric acid.