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EFFECT OF SOME GROWTH REGULATORS ON GROWTH AND YEILD OF SORGHUM, *Sorghum bicolor* (L) Moench

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ABSTRACT

GA3 or PCPAA significantly increased stem length, internode length, dry weight of stem or leaves per plant, but slightly increased number of stem internodes.CCC significantly decreased stem length, internode length, dry weight of stem or leaves per plant but slightly decreased number of internodes.

Transverse sections in the uppermost internode of sorghum stem revealed that GA3 induced more thickening and lignification in cell walls of different tissues, increased the amount of phloem per vascular bundles, promoted cell elongation and radial enlargement of ground parenchyma cells. CCC treatment showed retardation in thickening and lignification of vessels and peripheral mechanical tissue cell walls, maturation of ground tissue and elongation of ground tissue parenchyma cells.PCPAA increased the size of vascular bundle due to adnation of two adjacent bundles, or to the increase in the amount of vascular tissues of the individual bundle, and promoted cell elongation of the ground parenchyma.

GA3 and PCPAA promoted protein synthesis while CCC inhibited it in the two cultivars. GA3, PCPAA and CCC decreased total carbohydrates and crude fibers in grains of the two cultivars. Effect of growth regulators on ash percentage in sorghum grains varied to some extent according to cultivar and growth regulator used.

INTRODUCTION

Sorghum *Sorghum bicolor* (L.) Moench is considered as one of the most important cereal crops allover the world .In Egypt, sorghum crop ranked fourth after maize, wheat and rice from the stand point of its cultivated area and economic important. It is usually cultivated for human and animal feeding. Recently more attention has been given to sorghum cultivation where it can grow well under different sever conditions. Therefore it can grown successfully in new reclaimed areas. Increasing productivity of sorghum plants per unit area could be achieved through using high yielding cultivars and improving the agronomic practices.

More attentions has been given for increasing yield of this crop through controlling growth by growth regulating substances. Many workers reported that application of CCC induced positive effect on growth and yield of sorghum plant (Upadhyay and joshi 1971, Gill *et al*. 1976,Rao 1977, Raghavulu and Singh 1982, Sidha and Gill 1983, Goudreddy *et al.* 1986 and Gawande and Zode 1987). Gardner and kasberbouer (1961), Pauli and Stickler (1961), Romulu and Rongaswany (1972), Ven and Carter (1972), AL-Antably (1974), Rao *et al.* (1976), Williams and Morgan (1979), Tsai and Arteca (1985) and Morghan *et al*. (1987) found that treatment with GA3 enhanced growth and consequently yield of sorghum plants.

Some investigators mentioned that the phenoxy compound 2,4-D promoted plant growth and grain yield of sorghum (Korolev *et al*. 1971, Rao 1977). This work was carried out to study the influence of Gibberellic acid (GA3), cycocel (CCC) and para chlorophenoxy acetic acid (PCPAA) on growth and some anatomical characters as wll as yield and its components of sorghum.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive seasons of 1989 and 1990 at the Agricultural Research Center station of Giza, Egypt. The soil was clay loam with medium fertility. Grains of the two sorghum cultivars Giza 3 (long cv.) and 1007 (short cv.) were used and the following three growth regulators were adopted: Gibberellic acid (GA3) at concentrations of 0,25,50 and 100 ppm, Para chlorophenoxy acetic acid (PCPAA) at concentrations of 0,25,50 and 100 ppm, Chlormequat (CCC) at 0,1000,2000 and 3000 ppm

The experiments were laid in split plot design with three replications . Sorghum cultivars were arranged in the main plots where the different growth regulators treatments assigned at random within sub plots ($5.4m^2$).Sorghum grains were sown on June 26 th in both seasons. Sowing was carried out on ridges of 60 cm. apart and few grains were put in hills. After three weeks plants were thinned to two plants in hill. Plants were sprayed twice with each growth regulator , the first at 30 days and the second at 60 days after sowing. Samples of three plants from each sub plot were taken at 75 and 90 days after sowing (45 and 60 days after the first spray) to study the following parameters:

A-Morphological characters:-

1-Stem length. 2- Dry weight of stem. 3-Number of internodes .

4- Average internode length . 5- Dry weight of leaves.

B-Yield and its components:-

1- Number of grains 2-Head weight 3-Weight of 1000 grains

C-Chemical analysis:-

Samples were taken from grains then dried in an electric oven at 70^0c until a constant weight was achieved.

Total carbohydrates, protein, ash and fiber

A known weight of dried sample (2gm.) was digested with sulphoric acid (200 ml 1.25 %) then with sodium hydroxide solution (200 ml 1.25 %) and washed several times with diethyl ether . The residue was then dried at 110 c^0 to a constant weight and ashed at 550 ^oC (A.O.A.C., 1990) .

Statistical analysis:

All the data obtained were subjected to the proper statistical analysis according to the procedure outlined by Snedecor and Cochran 1967.New L.S.D. was calculated for comparisons between different means.

Anatomical studies:

It was intended to make comparative anatomical investigation on the plant material which showed extreme response to treatments. Specimens of the uppermost internode of sorghum stem when plants were 75 days old,15 days after the second spray were taken and preserved in F.A.A. solution (10 ml formalin,5 ml glacial acetic acid and 85 ml ethanol 70%). The selected materials were washed in 50% ethanol, dehydrated in normal butanol, embedded in paraffin wax (45-56^{o}C.m.p), sectioned at 20 U, double stained by crystal violet – erythrosin (Sass, 1951), cleared in xylene and mounted in Canada balsam. The obtained sections were carefully examined to detect histological manifestations of extreme response due to treatment.

RESULTS AND DISCUSSION

A- Stem growth:

1- Stem length

It is clear from Tables (1) and (2) that average stem length of sorghum plant significantly increased with the application of 50 and 100 ppm of GA_3 or PCPAA. The differences between the rate of 25ppm and control was significant only at the age of 90 days. On the other hand, stems of plants treated with any concentration of CCC were significantly shorter than those of untreated ones.

Table (1): Average stem length (cm) of sorghum, 75 days old, 15 days after the second spray, as affected with different concentrations of GA_3 , PCPAA and CCC

Seasons		First season			Second season		
Cultivars Treatments		Giza 3	1007	Average	Giza 3	1007	Average
Control		138.00	80.66	109.33	139.00	81.12	110.06
GA_3	25 ppm	140.52	82.16	111.34	141.25	83.29	112.27
	50 ppm	142.62	89.96	116.24	141.10	85.00	113.05
	100 ppm	144.00	86.43	115.22	146.12	88.00	117.06
PCPAA	25 ppm	141.12	86.00	113.56	145.00	85.11	115.05
	50 ppm	145.29	88.04	116.67	143.21	89.92	116.57
	100 ppm	149.25	93.00	121.13	150.09	91.00	120.55
CCC	1000 ppm	133.13	77.15	105.14	133.37	76.00	104.69
	2000 ppm	131.23	73.00	102.12	130.32	75.22	102.77
	3000 ppm	128.24	70.27	99.26	127.13	74.09	100.61
Average		139.34	82.67		139.86	82.87	

New L.S.D. :

Cultivars	**0.05**	**5.22**	**5.21**
	0.01	**6.61**	**8.91**
Treatments	**0.05**	**5.16**	**5.12**
	0.01	**7.51**	**7.61**

The average stem length of Giza 3 at the age of 90 days was 155.93 and 157.77cm while that of 1007 cultivar was 86.28 and 89.13 cm in the first and second seasons receptively. It is clear that there was highly significant difference between the two cultivars with respect to stem length Table (2).

Table (2): Average stem length (cm) of sorghum, 90 days old,30 days after the second spray, as affected with different concentrations of GA_3 , PCPAA and CCC

Seasons		First season			Second season		
Cultivars / Treatments		Giza 3	1007	Average	Giza 3	1007	Average
Control		154.00	86.52	120.26	155.06	85.00	120.03
GA_3	25 ppm	161.03	89.00	125.02	163.31	89.83	126.57
	50 ppm	165.13	92.27	128.70	167.87	95.53	131.70
	100 ppm	167.00	97.83	132.42	169.00	99.72	134.36
PCPAA	25 ppm	165.10	87.72	126.41	165.82	90.53	128.18
	50 ppm	167.21	86.00	126.61	168.21	93.23	130.72
	100 ppm	168.33	94.86	131.60	170.27	99.91	135.09
CCC	1000 ppm	140.52	79.28	109.90	141.21	80.00	110.61
	2000 ppm	136.62	75.35	105.99	139.72	79.21	109.47
	3000 ppm	134.36	74.00	104.18	137.20	78.31	107.76
Average		155.93	86.28		157.77	89.13	

New L.S.D. :			
Cultivars	**0.05**	**4.81**	**4.85**
	0.01	**7.96**	**7.99**
Treatments	**0.05**	**3.19**	**3.21**
	0.01	**4.62**	**4.71**

2- Number of main stem internodes.

Data in Table (3) show that in the two seasons average of the final number of stem internodes slightly increased with different concentrations of GA_3 and the highest rate of PCPAA with significant differences. CCC especially with the two rates of 2000 and 3000 ppm slightly decreased this parameter.

Table (3): Average number of internodes of sorghum, 90 days old, 30 days after the second spray, as affected with different concentrations of GA_3 , PCPAA and CCC

Seasons		First season			Second season		
Cultivars / Treatments		Giza 3	1007	Average	Giza 3	1007	Average
Control		10.58	7.53	9.06	10.56	7.56	9.06
GA_3	25 ppm	10.73	7.70	9.22	10.66	7.56	9.11
	50 ppm	10.60	7.63	9.12	10.73	7.73	9.23
	100 ppm	10.93	7.73	9.33	10.76	7.76	9.26
PCPAA	25 ppm	10.60	7.56	9.08	10.59	7.63	9.11
	50 ppm	10.63	7.66	9.15	10.64	7.73	9.19
	100 ppm	10.80	7.73	9.27	10.86	7.76	9.31
CCC	1000 ppm	10.33	7.40	8.87	10.46	7.45	8.96
	2000 ppm	10.24	7.32	8.78	10.32	7.35	8.84
	3000 ppm	10.15	7.35	8.75	10.24	7.27	8.76
Average		10.56	7.56		10.58	7.58	

New L.S.D. :			
Cultivars	**0.05**	**0.06**	**0.07**
	0.01	**0.09**	**0.11**
Treatments	**0.05**	**0.08**	**0.09**
	0.01	**0.09**	**0.12**

Comparing between the two cultivars, it is clear that Giza 3 developed higher number of internodes than did 1007 cultivar with highly significant differences.

3- Internode length:

It is clear from Table (4), that at the age of 90 days different concentrations of GA_3 and PCPAA significant or highly significant increased the average internode length. CCC on the other hand significantly decreased this character.

Table (4): Average internode length (cm) of sorghum stem 90 days old, 30 days after the second spray, as affected with different concentrations of GA_3 , PCPAA and CCC

Seasons		**First season**			**Second season**		
Cultivars Treatments		**Giza 3**	**1007**	**Average**	**Giza 3**	**1007**	**Average**
Control		14.67	13.63	14.15	14.50	13.50	14.00
GA_3	25 ppm	16.37	14.87	15.62	16.30	14.70	15.50
	50 ppm	16.60	14.43	15.52	16.42	14.50	15.46
	100 ppm	16.97	14.57	15.77	16.82	14.53	15.68
PCPAA	25 ppm	16.40	14.27	15.34	16.30	14.30	15.30
	50 ppm	16.50	14.33	15.42	16.40	14.43	15.42
	100 ppm	16.57	14.50	15.54	16.50	14.52	15.51
CCC	1000 ppm	14.20	12.40	13.30	14.25	12.50	13.38
	2000 ppm	14.27	12.40	13.34	14.30	12.51	13.41
	3000 ppm	14.43	12.53	13.48	14.40	12.57	13.49
Average		15.69	13.79		15.62	13.81	

New L.S.D. :			
Cultivars	**0.05**	**0.66**	**0.39**
	0.01	**1.00**	**1.11**
Treatments	**0.05**	**0.16**	**0.18**
	0.01	**0.23**	**0.25**

With respect to the difference between the two cultivars, it is obvious that Giza 3 developed stem with longer internodes as compared to 1007 cultivar with highly significant difference. The average internode length of Giza3 was 15.69 and 15.62 cm while that of 1007 cultivar was 13.79 and 13.81 cm in the two seasons respectively.

It could be concluded from the results of stem length, number of internode and average internode length, that the stimulative effect of GA_3 or PCPAA on stem elongation was mainly due to their effect on internode elongation since the internode length showed more response to treatment than number of internodes. The average internode length increased by about 12% and 10% while average internode number increased only by about 3% and 2.5%, with the highest concentration (100 ppm) of GA_3 and PCPAA respectively.

Promotive effect of GA_3 on sorghum stem length was also recorded by many workers, (Romulu and Rongaswany, 1972, Al-Antably 1974, Rao *et al*., 1976 and Tsai Arteca 1985). However, Gardner and Kasperbouer (1961) and Pauli and Stickler (1961) indicated that GA_3 had no effect on plant height of sorghum.

It could be concluded also that CCC, specially with the higher doses, retarded main stem elongation. This might be due to its retardant effect on internode elongation more than on the number of the differentiated internodes. The highest concentration of this growth regulator reduced average internode length by about 4% and average number of internodes by about 3.2%. This result is more or less in accordance with the findings of Al-Antably (1974), Gill *et al*., (1976), Roa (1977), Goudreddy *et al*.,(1986) and Gawande and Zode(1987).

The difference recorded in stem length between the two cultivars of sorghum could be attributed to the difference in both length and number of main stem internodes.

B- Internal structure of sorghum stem

1-Effect of GA_3:

Transverse sections in the uppermost internode of sorghum stem (1007 cultivar) when plants were 75 days old, 15 days after the second spray revealed that 100ppm GA_3 treatment induced more thickening and lignification in cell walls of epidermis, *peripheral sclerenchyma* and *vessel members* in comparsion with control. An increase in the amount of phloem was also observed in the vascular bundles of treated stems due to the increment in size and number of sieve tube members with their companion cells, Fig (1,a). Vessels of metaxylem in GA_3 treated stems were nearly ovate in shape, while in control ones were round. Protoxylem lacunae showed more development in GA_3 treated stems, specially in the inner vascular bundles. This might be due to the enhancement of internode elongation after treatment with GA_3 , and consequently the obliteration of protoxylem vessels was accelerated. Number of vascular bundles was not affected with GA_3 treatment.

In this connection El-Shaarawi and El-Sherbeny (1982) found that GA_3 at the rate of 600 ppm promoted the development and differentiation of phloem tissue, specially fibers, in the stem of roselle. While the amount of xylem was negatively affected.

As shown in Fig. (1,a) ground parenchyma around the vascular bundles, specially the inner ones, were smaller with condensed cytoplasm in the control stems. In GA_3 treated stems, these parenchyma well vaculated, radialy elongated and were larger than those of untreated ones. It could be concluded therefore that GA_3 accelerated the differentiation of ground parenchyma.

Longitudinal sections in the uppermost internode of sorghum stem, 15 days after the second spray exhibited that treatment with GA_3 promoted cell elongation and radial enlargement of ground parenchyma cells Fig (2,a). Thus, it could be concluded that the increase in internode length due to treatment with GA_3 was attributed mainly to its stimulative effect on cell elongation. This result is in accordance with the findings of El-Shaarawi and El-Sherbeny (1982) on roselle plant. On the other hand, El-Shaarawi (1976) found that the length of the individual cell of wheat stem was not affected with GA_3.

2. Effect of CCC:

At the age of 75 days, 15 days after the second spray, stems of CCC 3000ppm treatment showed retardation in thickening and lignification of peripheral mechanical tissue cells and vessel members Fig (1,b).

Maturation of ground tissue was also supressed, since its cells were smaller with less vaculation as compared with ground tissue of control stems. This result is in accordance with the findings of Zaher *et al*., (1973) on wheat. They found that CCC delayed ear emergence by retarding the development of cells of ear peduncle. El-Shaarawi and El-Sherbeny (1982) reported that CCC at the rate of 4000 ppm inhibited the production and differentiation of vascular tissues as well as cell elongation in roselle stem.

Longitudinal sections revealed that treatment with 3000 ppm of CCC retarded the elongation of ground parenchyma cells Fig (2,b) It could be concluded therefore, that the decrease in internode elongation in CCC-treated stems might be due mainly to its retarding effect on cell elongation. This result agrees with the findings of El-Shaarawi and El-Sherbeny (1982) on roselle plant.

3-Effect of Pcpaa

At the age of 75 days, 15 days after the second spray some pronounce modifications in the internal structure of PCPAA treated stems specially in vascular system were observed. Many vascular bundles of superior size were developed Fig (1,c) This modification in bundle size was due either to the increase in the amount of vascular tissues of the individual vascular bundle or to the adnation of two adjacent bundles. The increase in the amount of vascular tissues was due to the increase in both phloem and xylem. In some bundles two rows of protoxylem vessels, and sometimes three large metaxylem vassels were developed. A noticeable increase in the amount of tracheids between the metaxylem vessels was also observed.The increase in the amount of phloem was due to the increase in both number and size of sieve tube members. Tangential extention of phloem was also observed in PCPAA treated stems, subsequently it became rectangular in shape, while it was triangular in untreated stems. Adnation of adjacent vascular bundles occurred in treated stems through their bundle sheaths. The two vascular strands still independent but they bounded by one large sheath resulted from the adnation of the two sheaths own to such bundles. No clear differences were recorded in the number of vascular bundles or in the ground tissue between PCPAA treated stems and those untreated.

Longitudinal sections in the stem show that PCPAA promoted cell elongation of the ground parenchyma. This led to the conclusion that cell elongation play an important role in increasing the length of internodes of treated stems.

It is worthy to notice that the anatomical modifications in sorghum stem due to treatment with GA_3, CCC or PCPAAwere observed for the two studied cultivars but the effect was more pronounced on 1007 cultivars.

fig

Dry weight of stem:

Data in Tables (5) and (6), show that different concentrations of GA_3 or PCPAA significantly increased the average dry weight of stem per plant. This effect of both growth regulators significantly increased by raising the concentration. However, PCPAA was more effective in this respect. On the other hand CCC significantly decreased the dry weight of stem per plant specially when used with the concentration of 3000 ppm.

Comparing between the two cultivars it is obvious that irrespective treatments, Giza 3 produced stems with dry weight higher than that of 1007 cultivar with significant difference.

Table (5): Average dry weight (gm) of sorghum stem, 75 days old, 15 days after the second spray, as affected with different concentrations of GA_3 , PCPAA and CCC

Seasons		First season			Second season		
Cultivars / Treatments		Giza 3	1007	Average	Giza 3	1007	Average
Control		90.82	79.20	85.01	93.16	82.59	87.85
GA_3	25 ppm	96.54	92.72	94.63	117.08	111.06	114.07
	50 ppm	102.65	95.98	99.32	117.26	115.25	116.26
	100 ppm	123.37	100.94	112.16	125.62	119.21	122.42
PCPAA	25 ppm	133.58	117.88	125.73	122.84	121.82	122.03
	50 ppm	129.75	127.05	128.40	126.09	125.41	125.75
	100 ppm	130.60	137.71	134.16	138.28	136.58	137.43
CCC	1000 ppm	73.05	69.87	71.46	72.21	71.90	72.06
	2000 ppm	73.01	67.41	70.21	68.74	68.29	68.49
	3000 ppm	67.43	65.04	66.24	67.51	66.68	67.10
Average		102.08	95.38		104.87	101.81	

New L.S.D. :			
Cultivars	**0.05**	**6.27**	**6.28**
	0.01	**10.37**	**10.39**
Treatments	**0.05**	**5.46**	**5.49**
	0.01	**7.93**	**7.96**

Table (6): Average dry weight (gm) of sorghum stem, 90 days old, 30 days after the second spray, as affected with different concentrations of GA_3 , PCPAA and CCC

Seasons		First season			Second season		
Cultivars / Treatments		Giza 3	1007	Average	Giza 3	1007	Average
Control		124.82	115.30	120.06	125.38	117.94	121.66
GA_3	25 ppm	130.90	120.54	125.72	129.40	124.30	126.85
	50 ppm	135.22	124.04	129.63	136.34	124.44	130.39
	100 ppm	143.37	124.84	134.11	143.61	127.21	135.41
PCPAA	25 ppm	131.06	133.05	132.06	130.86	131.54	131.20
	50 ppm	135.55	134.72	135.14	134.87	134.50	139.69
	100 ppm	146.04	139.81	142.93	144.87	135.20	140.09
CCC	1000 ppm	117.22	79.98	98.60	118.23	81.41	99.82
	2000 ppm	112.36	76.54	94.45	113.65	77.91	95.78
	3000 ppm	111.87	75.54	93.71	111.21	76.57	93.89
Average		128.84	112.44		128.84	113.11	

New L.S.D. :			
Cultivars	**0.05**	**3.91**	**4.02**
	0.01	**6.47**	**6.49**
Treatments	**0.05**	**5.51**	**5.62**
	0.01	**8.01**	**8.21**

Dry weight of leaves:

It is clear from Tables (7) and (8) that applications of GA_3 or PCPAA greatly affected the dry weight of leaves per plant. Using any concentration of both growth regulators induced highly significant increase in this character.

Table (7): Average dry weight (gm) of leaves of sorghum, 75 days old, 15 days after the second spray, as affected with different concentrations of GA_3 , PCPAA and CCC

Seasons			First season			Second season		
Cultivars / Treatments			Giza 3	1007	Average	Giza 3	1007	Average
Control			31.03	24.27	27.65	34.78	25.74	30.26
GA_3	25	ppm	36.60	31.83	34.22	38.01	35.91	26.96
	50	ppm	34.89	34.16	34.53	41.27	37.41	39.34
	100	ppm	42.51	34.97	38.74	44.12	38.57	41.35
PCPAA	25	ppm	34.53	30.21	32.37	36.84	33.94	35.89
	50	ppm	37.42	37.16	37.29	39.89	33.89	36.87
	100	ppm	39.06	38.76	38.91	38.51	34.94	36.73
CCC	1000	ppm	27.77	19.84	23.81	27.76	23.05	25.41
	2000	ppm	26.53	17.54	22.04	26.98	21.14	24.06
	3000	ppm	24.16	15.89	20.03	22.15	19.94	21.05
Average			33.45	28.46		35.03	30.45	

New L.S.D. :		First season	Second season
Cultivars	0.05	1.99	1.28
	0.01	2.37	2.31
Treatments	0.05	2.37	2.40
	0.01	3.11	3.21

As to the effect of CCC a significant decrease in average dry weight of leasves of treated plants was recorded when compared with control ones. The highest rate of CCC (3000 ppm) was more effective in this respect.

Comparing between the two cultivars of sorghum, it is obvious that Giza 3 developed leaves with higher dry weight than those of 1007 cultivar with significant difference.

It could be concluded from the results of the dry weight of stems and leaves that GA_3 and PCPAA stimulated the accumulation of dry matter in stem and leaves of sorghum plant. This result is more or less in accordance with the findings of *Hassan et. al*.,(1976) with GA_3 on maize, and *Rao* et al., (1976) on sorghum.

On the other hand, treatment with CCC negatively affected the accumulation of dry matter in stems and leaves of sorghum plant. In this connection *Rao* (1977) mentioned that total dry matter of sorghum was unaffected by treatment with 500 or 1000 ppm of CCC.

Table (8): Average dry weight (gm) of leaves of sorghum, 90 days old, 30 days after the second spray, as affected with different concentrations of GA_3 , PCPAA and CCC

Seasons		First season			Second season		
Cultivars / Treatments		**Giza 3**	**1007**	**Average**	**Giza 3**	**1007**	**Average**
Control		47.31	35.31	41.31	45.79	35.41	40.58
GA_3	25 ppm	52.37	43.21	47.79	54.55	42.91	48.73
	50 ppm	54.91	44.55	49.73	56.08	44.59	50.34
	100 ppm	56.54	48.38	52.46	47.57	45.76	51.67
PCPAA	25 ppm	50.75	40.17	45.46	49.61	42.71	46.16
	50 ppm	50.91	47.21	49.06	49.83	44.93	47.38
	100 ppm	53.44	49.04	51.24	52.24	47.29	49.77
CCC	1000 ppm	40.94	32.50	36.72	41.74	34.50	38.12
	2000 ppm	39.54	31.84	35.69	38.87	30.61	34.74
	3000 ppm	36.14	31.10	33.62	28.24	30.54	29.39
Average		48.29	40.33		47.45	35.93	

New L.S.D. :

Cultivars	**0.05**	**2.21**	**2.25**
	0.01	**3.11**	**3.75**
Treatments	**0.05**	**3.09**	**3.10**
	0.01	**3.92**	**3.83**

D- Yield and its componants

It is clear from Tables (9, 10, 11 and 12) that application of GA3 and PCPAA to sorghum plants specially at the higher two rates significantly increased average number of grains per head, head weight and grain yield in ardab per Feddan. Weight of 1000 grains showed significant decrease in the first season and showed no significant response to both growth regulators in the second one.

It could be concluded therefore that the recorded increase in grain yield by GA3 and PCPAA treatments was due to mainly to the increase in number of grains per head. The positive effects of GA3 and phenoxy compounds on grain yieldy of sorghum was found by Rao *et.al* (1976), Sarp and Dunle (1980), Retzinger and Richard (1983) and Ali and Rao (1987).

Using CCC at the rate of 1000 ppm significantly increased head weight and grain yield in ardab per feddan and decreased the grain number per head and average weight of 1000 grains. The higher two rates of CCC (2000 and 3000 ppm) showed insignificant effect on both head weight and grain yield in ardab per Feddan , though the average grain number per head and weight of 1000 grains were significantly decreased, (Tables 9,10,11 and 12). These results are more or less in agreement with the findings of Upadhgay and Joshi (1971), Gill *et. al* (1976) , Rao (1977) and Goudreddy *et.al* (1986).

Table (9): Average number of grains per head of sorghum as affected with different concentrations of GA_3, PCPAA and CCC

Seasons		First Season			Second Season		
Cultivers Treatments		**Giza 3**	**1007**	**average**	**Giza 3**	**1007**	**Average**
Control		1177.26	1071.31	1124.29	1008.33	1065.00	1036.67
GA_3	25 PPM	1090.61	1358.00	1199.31	1017.33	1311.93	1164.63
	50 PPM	1137.43	1692.02	1414.73	1140.26	1701.66	1420.96
	100 PPM	1599.21	1733.41	1666.31	1585.00	1727.00	1656.00
PCPAA	25 PPM	1046.81	1080.21	1063.51	1145.00	1085.33	1115.17
	50 PPM	1402.31	1278.33	1340.32	1250.20	1269.13	1259.67
	100 PPM	2100.00	1390.00	1745.00	2057.12	1374.03	1715.58
CCC	1000 PPM	939.21	945.62	942.42	952.33	893.00	922.67
	2000 PPM	848.03	892.12	870.08	870.00	875.00	872.50
	3000 PPM	831.21	871.00	851.11	833.00	855.00	844.00
Average		1212.21	1231.20		1185.86	1215.71	

New L.S.D. :			
Cultivers	**0.05**	**71.02**	**75.04**
	0.01	**117.12**	**118.21**
Treatments	**0.05**	**86.40**	**87.50**
	0.01	**125.69**	**126.23**

Table (10): Average head weight of sorghum as affected with different concentrations of GA_3, PCPAA and CCC

Seasons		First Season			Second Season		
Cultivers Treatments		**Giza 3**	**1007**	**Average**	**Giza 3**	**1007**	**average**
Control		63.02	55.35	59.18	62.95	55.77	59.36
GA_3	25ppm	72.69	60.65	66.67	73.21	59.92	66.56
	50 PPM	83.03	66.49	74.76	83.91	56.71	74.84
	100 PPM	93.94	71.55	82.75	92.21	73.01	82.61
PCPAA	25 PPM	107.96	77.49	92.74	106.99	78.21	92.80
	50 PPM	112.93	82.01	97.77	113.95	83.31	98.63
	100 PPM	118.69	85.66	102.18	119.73	86.21	102.97
CCC	1000 PPM	68.35	53.16	60.75	68.95	53.27	61.11
	2000 PPM	66.56	52.31	59.44	66.92	52.27	59.59
	3000 PPM	65.38	51.86	58.61	67.71	51.82	59.77
Average		85.26	65.71		85.60	65.96	

New L. S. D.			
Cultivers	**0.05**	**0.13**	**0.13**
	0.01	**0.22**	**0.21**
Treatments	**0.05**	**0.91**	**0.91**
	0.01	**1.31**	**1.31**

2- Chemical composition of sorghum grains .

Data in Tables (13) and (14) reveal that spraying sorghum plants with GA3 or PCPAA increased protein percentage in grains of the two studied cultivars, Giza 3 and NES 1007.This increment increased by raising the dose of growth regulator. On the other hand, CCC treatment decreased protein percentage in grains of both cultivars in comparison with control. It could be concluded therefore, that GA3 and PCPAA promoted protein synthesis while CCC inhabited it.

Total carbohydrates of sorghum grains in the two studied cultivars was decreased due to treatment with GA3 or PCPAA. CCC treatment showed a slight decrease in this aspect. As to crude fiber content, it is clear that treatment with GA3, PCPAA or CCC decreased this aspect in both cultivars.

Effect of growth regulators on ash percentage in sorghum grains varied to some extent according to cultivar and growth substance used. Giza 3 cultivar showed increase in this aspect due to treatment with any of the three growth regulators used. NES 1007 cultivar exhibited decrease in ash content with the application of GA3 or PCPAA and increase with CCC treatment (Tables 13 and 14) .

Table (11): Average weight of 1000 grains of sorghum as affected with different concentrations of GA_3, PCPAA and CCC

Seasons			**First Season**			**Second Season**		
Cultivers Treatments			**Giza 3**	**1007**	**average**	**Giza 3**	**1007**	**average**
Control			55.63	53.13	54.38	55.98	55.06	55.52
GA_3	25	PPM	57.06	54.5	55.78	55.68	55.62	55.05
	50	PPM	58.06	54.63	56.35	55.98	55.98	55.98
	100	PPM	58.20	54.86	56.53	55.78	55.06	55.42
PCPAA	25	PPM	56.33	53.70	55.02	56.14	54.12	55.13
	50	PPM	57.70	52.72	55.22	56.95	54.99	55.72
	100	PPM	56.23	54.36	55.30	54.78	54.86	54.82
CCC	1000	PPM	55.90	55.60	55.75	54.78	55.42	55.10
	2000	PPM	55.60	54.36	54.98	54.91	53.82	54.37
	3000	PPM	54.73	53.50	54.12	54.32	52.62	53.47
Average			56.54	54.14		55.53	54.49	

New L.S.D :			
Cultivers	**0.05**	**0.63**	**0.65**
	0.01	**1.04**	**1.14**
Treatments	**0.05**	**0.79**	**0.72**
	0.01	**1.14**	**1.15**

Table (12): Average grain yield in ardab/feddan of sorghum as affected with different concentrations of GA3 ,PCPAA and CCC

Seasons			**First Season**			**Second Season**		
Cultivers Treatments			**Giza 3**	**1007**	**average**	**Giza 3**	**1007**	**average**
Control			12.31	12.12	12.22	12.33	12.02	12.18
GA	25	PPM	12.66	13.31	12.99	12.43	12.97	12.70
	50	PPM	14.00	14.66	14.33	13.35	13.21	13.28
	100	PPM	15.00	14.21	14.61	13.77	15.61	13.69
PCPAA	25	PPM	13.32	14.71	14.02	12.85	13.21	13.03
	50	PPM	13.13	14.08	13.61	13.31	13.21	13.26
	100	PPM	14.00	15.00	14.50	14.33	14.62	14.48
CCC	1000	PPM	12.51	13.00	12.76	12.66	13.21	12.94
	2000	PPM	12.44	12.62	12.53	12.51	12.77	12.64
	3000	PPM	12.31	12.31	12.31	12.41	12.32	12.37
Average			13.17	13.60		12.95	13.12	

New L.S.D :			
Cultivers	**0.05**	**0.74**	**0.76**
	0.01	**1.77**	**1.79**
Treatments	**0.05**	**0.49**	**0.50**
	0.01	**0.72**	**0.80**

Table (13) : Chemical composition of sorghum grains (Giza3 Cultivar) as affected with different concentrations of GA3 , PCPAA and CCC during two seasons .

Seasons / Treatments		First season				Second season			
		protein	Carbohydrate	Fiber	Ash	protein	Carbohydrate	Fiber	Ash
Control		13.70	77.50	2.80	1.73	13.66	77.26	2.80	1.72
3 GA	25 PPM	15.63	75.50	2.03	1.86	15.73	77.34	2.12	1.87
	50 PPM	18.70	73.50	2.40	1.76	18.80	76.28	2.31	1.75
	100 PPM	19.36	73.60	2.50	1.50	19.46	74.31	2.50	1.52
PCPAA	25 PPM	15.26	73.86	2.13	1.76	15.23	75.81	2.00	1.74
	50 PPM	16.20	74.77	2.37	1.90	16.30	75.85	2.40	1.90
	100 PPM	16.30	75.63	2.53	1.96	16.60	75.81	2.53	1.94
CCC	1000PPM	12.70	78.60	2.60	2.20	12.80	78.44	2.73	2.21
	2000PPM	12.40	77.77	2.40	2.00	12.30	77.91	2.40	2.10
	3000 PPM	12.23	77.40	2.23	1.90	12.10	78.40	2.23	1.92

Table (14): Chemical composition of sorghum grains (1007 Cultiver) as affected with different concentrations of GA3 , PCPAA and CCC during two seasons.

Seasons		First season				Second season			
Seasons Treatments		protein	Carbohydrate	Fiber	Ash	protein	Carbohydrate	Fiber	Ash
Control		13.48	78.73	2.10	1.70	13.26	77.70	2.16	1.71
3 GA	25 PPM	15.43	77.53	1.40	1.43	15.46	77.50	1.40	1.44
	50 PPM	16.20	77.48	1.70	1.66	16.10	77.05	1.86	1.65
	100 PPM	16.80	77.59	1.87	1.09	16.70	77.60	1.73	1.01
PCPAA	25 PPM	15.70	77.76	1.50	1.30	15.56	77.07	1.60	1.31
	50 PPM	15.86	77.86	1.70	1.50	15.83	77.07	1.86	1.02
	100 PPM	18.30	78.50	1.87	1.66	18.06	77.02	1.90	1.05
CCC	1000 PPM	13.16	78.33	2.09	2.73	13.30	78.34	2.03	2.74
	2000 PPM	12.70	78.23	1.80	2.33	12.70	78.33	1.91	2.31
	3000 PPM	12.70	78.06	1.43	2.35	12.86	78.17	1.53	2.29

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تأثير بعض منظمات النمو على النمو والمحصول فى الذرة الرفيعة

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أدت معاملة نباتات الذرة الرفيعة بالجبرلين أو الباراكلوروفينوكس إلى زيادة معنوية فى متوسط طول الساق وطول السلامية ووزن الساق الجاف وأيضاً عدد أوراق النبات وزيادة بسيطة فى عدد سلاميات الساق .

رش النباتات بالسيكوسيل أظهر نقص معنوى فى متوسط طول الساق وطول السلامية ووزن الساق الجاف وعدد أوراق النبات ونقص بسيط فى عدد السلاميات .

أظهرت القطاعات العرضية فى السلامية العليا للساق المعاملة بالجبرلين زيادة فى سمك الجدر الخلوية ودرجة تلجننها فى بعض الأنسجة وأيضاً زيادة فى كمية اللحاء فى الحزم الوعائية وإستطالة خلايا النسيج الأساسى البارنشيمية . وقد أدت المعاملة بالسيكوسيل إلى تقليل سمك الجدر ودرجة تلجننها فى الأوعية وجدر خلايا الأنسجة الميكانيكية الخارجية وأظهرت القطاعات التشريحية فى السيقان المعاملة بالباراكلوروفينوكس زيادة فى حجم الحزمة الوعائية نتيجة لإندماج حزمتين متقاربتين معاً أو لزيادة كمية الأنسجة الوعائية فى كل حزمة .

رش نباتات الذرة الرفيعة بالجبرلين أو الباراكلوروفينوكس زاد تخليق البروتين بينما سبب الرش بالسيكوسيل تثبيطه .

أدى الرش بمنظمات النمو الثلاثة إلى نقص الكربوهيدرات والألياف فى الحبوب فى الصنفين . أما نسبة الرماد فكانت مختلفة فى الحبوب حسب الصنف ومنظم النمو .