EFFECT OF GA_3 AND IAA ON GROWTH
AND YIELD OF SOME MAIZE VARIETIES

BY

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ABSTRACT

Two field experiments were conducted at the Agricultural Research and Experiment Center, Faculty of Agriculture at Moshtohor, Kalubia, Egypt, during 1986 and 1987 seasons. The aim of the investigation was to study the response of three maize varieties to soaking their grains in solution of two growth regulators (GA_3 and IAA) at three concentrations, i.e. 40, 80 and 120 ppm for 12 hours.

S.C. 103 surpassed the other two varieties in plant height, ear diameter, number of grains/row, ear weight, weight of grains/ear, T.W.C. 310 gave higher ear position and higher shelling percentage, but D.C. 202 produced higher number of rows/ear. The three varieties were similar for stem diameter, number of green leaves/plant after 90 days from sowing, ear length, number of grains/ear, number of ears/plant and 100-grain weight.

Soaking maize grains in GA_3 or IAA under different concentrations decreased stem diameter and number of green leaves/plant as compared with the control treatment. GA_3 at 40 ppm increased plant height and 100-grain weight and gave the lowest grain weight/plant, but IAA at 120 ppm produced the highest values of ear and grain weight/plant. IAA at 40 ppm decreased number of grains/row as compared with 80 ppm of both IAA and GA_3. Number of rows/ear increased by GA_3 at 80 ppm as compared with 40 ppm. The highest number of grains/ear was obtained by GA_3 at 80 ppm and the lowest number was produced by IAA at 40 ppm. Both growth regulators did not affect ear length, ear diameter, ear weight, grain weight/ear, number of ears/plant, shelling percentage, yield of ears and grain/fed.

Positive correlation coefficient was obtained between grain yield and each of yield of ear, number of grains/row, number of grains/ear, ear diameter and ear length.

INTRODUCTION

Maize (Zea mays L.) is an important cereal crop in Egypt, used for human consumption and many other purposes. Many investigators, have shown that maize hybrids proved to be one of the most effecient tools for raising maize yields (El-Hattab et al., 1979; Moursi et al., (1979); Raghip, 1979 and Hussein et al., 1980). In addition, Gouda (1982), found that S.C. 14 produced the highest grain yield/ plant and per feddan followed by V.C. 80 and D.C. 19. Moreover, Khalifa et al. (1983), reported that, S.C. 14 surpassed the other varieties in yield and its components. Also, Al-Naggar (1987), indicated that S.C. 9 and T.W.C. 310 always yielded more than Cairo 1, T.W.C. 309 and S.C. 10.

Several investigators studied the relationship between some growth regulators and yield and yield components of maize. Khalil (1965), Shafshak et al., (1980) and Fahmy et al. (1988), indicated that, soaking the grains with solution of GA_3, IAA, 2-4-D as well as CCC increased number of ears/plant, ear length, grain yield of maize and grain yield/panicle, seed index and grain yield of sorghum. On the other hand, Cherry et al., (1960) and Rizk & El-Antably (1974), reported that, soaking maize or sorghum grains in solutions of GA_3, ABA and thiourea had no significant effect on grain yield. Shafshak et al. (1984), found that the ear length, ear diameter, number of rows/ear, ear weight, number of grains/ear, shelling percentage and grain yield/fed. were not significantly affected by growth regulators. Hence, this work was conducted to investigate the response of three maize varieties to different concentration of GA_3 and IAA.

MATERIAL AND METHODS

Two field experiments were conducted at the Agricultural Research and Experiment Center, Faculty of Agriculture at Moshtohor, Kalubia, Egypt, during 1986 and 1987 seasons to study the effect of some growth regulators on growth and yield of three maize varieties. The soil is clay loam with a pH value of 7.8 and 2.5% organic matter content. Each experiment included 21 treatments which were the combinations of three maize varieties and seven treatments of growth regulators. Factors under study were:

A- **Maize varieties:**
1- Single cross 103 (S.C. 103).
2- Double cross 202 (D.C. 202).
3- Three way cross 310 (T.W.C. 310).

B- **Growth regulators:**

Maize grains were soaked in gibbrellic acid (GA_3) or indole acetic acid (IAA) solution for 12 hours before sowing. The treatments of growth regulators were:

1- Soaking in water (control).
2- GA_3 at concentration of 40 ppm.
3- GA_3 at concentration of 80 ppm.
4- GA_3 at concentration of 120 ppm.
5- IAA at concentration of 40 ppm.
6- IAA at concentration of 80 ppm.
7- IAA at concentration of 120 ppm.

The experimental design was split plot with four replications. Maize varieties were arranged at random in the main plots and growth regulators in sub-plots. Each sub-plot was 1/400 fed. (10.5 m^2) consisted of 5 ridges, 3 m long and 70 cm apart. Sowing date was june, 24 and 30 in 1986 and 1987 seasons, respectively. The normal cultural practices of growing maize were followed.

A random sample of 10 plants was taken from each sub-plot at 90 days from sowing to recorded: plant height, ear height, stem diameter and number of green leaves/plant. At harvesting, ten ears were selected at random from each sub-plot for studying ear characters, namely, ear length, ear diameter, number of grains/row, number of rows/ear, number of grains/ear, ear weight, weight of grains/ear, shelling percentage and 100-grain weight. All maize plants of each sub-plot were harvested to estimate, number of ear/plant, weight of ears/plant, weight of grains/plant, ears yield and grain yield/fed.

Data of the two seasons were subjected to combined analysis according to Sendecor and Cochran (1967). L.S.D. at the levels of 0.05 was used at compare the treatment means (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

I- **Effect of Varieties:**

A- **Effect of growth characters:**

1- **Plant height:**

Results in Table (1) show that varieties exhibited significant effects on plant height of maize plant. Single cross 103 produced significantly higher plants than either T.W.C. 310 and D.C. 202. The differences in plant height between varieties are attributed to difference in the genetical make-up. Similar results were obtained by El-Hattab <u>et al.</u>, (1979). Moreover, Gouda (1982), found that D.C. 19 was the tallest variety, while S.C. 14 was the shortest.

Nevertheless, Khalifa et al. (1983), reported that S.C. 14 and D.C. 355 were medium in height.

2- **Ear height:**

With regared to the varieties effect, data presented in Table (1) show that there was a significant effect on ear height. T.W.C. 310 had significantly higher ear position than the other two varieties. Similar conclusion was obtained by Gouda (1982), who reported that D.C. 19 was the highest in ear position, while S.C. 14 was the lowest one.

3- **Stem diameter:**

Maize varieties did not significantly differ in stem diameter. All differences between varieties failed to reach the significant level (Table 1). These results did not agree with those obtained by Gouda (1982), who reported that D.C. 19 was more thicker than S.C. 14.

4- **Number of green leaves/plant:**

The effect of maize varieties on number of green leaves/plant was similar to that of stem diameter (Table 1). Similar result was obtained by Hussein et al. (1980), who reported that the differences in number of green leaves/plant among V.C. 69, D.C. 355 and shedwan were not significant. On the other hand, Nigem (1976) and Gouda (1982), found that the different genotypes differed significantly in number of leaves/plant.

Table (1): Some growth characters of some maize varieties (Combined analysis of 1986 and 1987 seasons).

Cultivars	Plant height (cm)	Ear height (cm)	Stem diameter (cm)	No. of green leaves/plant
S.C. 103	257.0	124.4	2.4	10.7
D.C. 202	245.0	129.2	2.4	10.9
T.W.C. 310	248.2	135.1	2.4	10.8
L.S.D. at 5%	5.8	4.8	N.S	N.S

B- Effect on yield and yield components:

1- **Ear length:**

Results in Table (2) show that ear length was not significantly affected by maize varieties. Similar results were obtained by many investigatores, Yakout (1977), reported insignificant differences in ear length between American early and D.C. 186. Also, Raghip (1979) and Hussein et al. (1980), found no significant differences in ear length among V.C. 80, D.C. 355 and Shedwan as well as V.C. 69. On the other hand, Khalifa et al. (1983), found that, S.C. 14 produced longer ears than D.C. 335.

2- **Ear diameter:**

It is clear from Table (2) that varieties exhibited significant differences in ear diameter. S.C. 103 surpassed the other two varieties in ear diameter, while T.W.C. 310 ranked second followed by D.C. 202. This result did not agree with those obtained by Yakout (1977); Raghip (1979); Hussein et al., (1980) and Gouda (1982).

3- **Number of rows/ear:**

Data presented in Table (2) indicate that differences among maize varieties in number of rows/ear were significant. Evidently D.C. 202 had significantly higher number of rows/ear than S.C. 103. The superiority of D.C. 202 in number of rows/ear may mostly be due to the fact that this variety is characterized by lower ear length and greater diameter than the other two varieties. In general, this result is in agreement with those obtained by Hussein et al., (1980) and Gouda (1982).

4- **Number of grains/row:**

Number of grains/row was significantly affected by maize varieties. S.C. 103 outnumbered variety D.C. 202 in number of grains/row (Table 2). The superiority of S.C. 103 in this character is mostly due to higher ear length than other two varieties. Similar result was obtained by Gouda (1982).

5- **Number of grains/ear:**

Data presented in Table (2) indicate clearly that maize varieties did not significantly differ in number of grains/ear. S.C. 103 gave the highest number, but all differences failed to reach the significant level. Khalifa et al. (1983), found that, S.C. 14 produced more grains/ear as compared with D.C. 355.

6- **Ear weight and ear grain weight:**

All differences among maize varieties in ear weight as well as weight of grains/ear were statistically significant (Table 2). S.C. 103 produced heavier ears and grains/ear than the other two varieties. Nevertheless, the difference between T.W.C. 310 and D.C. 202 was insignificant. Heavier ears as well as grains/ear of S.C. 103 were mainly due to higher ear length, ear diameter and number of grains/row. These results could be confirmed by those obtained by Raghip (1979), Hussein et al., (1980) and Khalifa et al. (1983).

7- Number of ears/plant:

Results in Table (2) show that all differences among maize varieties in number of ears/plant were not significant. These results did not agree with those obtained by El-Hattab et al., (1979); Hussein et al., (1980) and Gouda (1982).

8- Ear weight/plant and grain weight/plant:

Maize varieties showed significant differences in ear weight as well as grain weight/plant (Table 2). S.C. 103 significantly outweighed the other two varieties followed by T.W.C. 310 and D.C. 202. Higher grain yield of S.C. 103 may mainly be attributed to higher ear length, ear diameter, ear weight as well as grain weight/ear. These results are in harmony with those obtained by Yokout (1977); Raghip (1979); Hussein et al., (1980) and Gouda (1982).

9- Shelling percentage:

Differences in shelling percentage among maize varieties were significant as shown in Table (2). T.W.C. 310 gave the highest shelling percentage. Similar result was obtained by Hussein et al., (1980). On the other hand, El-Hattab et al., (1979) as well as Gouda (1982), mentioned that composites and D.C. 19 varieties surpassed the other varieties in this character. Also, Khalifa et al. (1983), reported that S.C. 14 gave higher shelling percentage than D.C. 355.

10- Weight of 100 grains:

Results in Table (2) indicate clearly that the weight of 100 grains was not significantly influences by maize varieties under this investigation. This result agrees with those obtained by Raghip (1979).

11- Yields of ears and grain/feddan:

DIfferences in yields of ears and grain/fed. due to maize varieties were significant (Table 2). S.C. 103 produced the highest yield followed by T.W.C. 310 and D.C. 202. The superiority of S.C. 103 may be largely due to its highest mean performance of many characters, i.e., ear length, ear diameter, ear weight and weight of grain/plant. These results agree with the findings of Raghip (1979); Hussein et al., (1980) and Gouda (1982). Al-Naggar (1987) indicated that S.C. 19 and T.W.C. 310 always yielded Cairo 1, T.W.C. 309 and S.C. 10.

Table (2): Yield and yield components of some maize varieties (Combined analysis of 1986 and 1987 seasons).

Cultivars	S.C. 103	D.C. 202	T.W.C. 310	L.S.D. at 5%
Ear Length (cm)	20.10	19.80	20.00	N.S.
Ear diam. (mm)	46.40	44.60	45.20	0.9
No. of rows per ear	12.00	12.40	12.20	0.2
No. of grains per row	44.20	41.20	43.10	1.3
No. of grains per ear	531.20	514.30	528.80	N.S.
Ear weight (gm)	208.90	179.90	186.60	11.7
Grain weight per ear (gm)	164.80	141.60	148.90	10.1
No. of ears per plant	0.96	0.92	0.94	N.S.
Ear weight/plant (gm)	191.70	155.60	164.20	13.3
Grain weight/plant (gm)	150.80	122.70	132.20	11.2
Shelling %	78.50	78.50	79.60	0.9
100-grain weight (gm)	33.90	33.00	34.30	N.S.
Ear yield/fed (kg)	3569.20	2853.70	2900.80	247.2
Grain yield/fed (kg)	2820.40	2255.50	2318.40	201.0

II- Effect of growth regulators:

A- Effect on growth characters:

1- Plant height:

Results in Table (3) demonstrate clearly that plant height of maize was significantly affected by the growth regulator treatments. However, the first concentration of GA_3 (40 ppm) was more effective in increasing plant height. Similar result was obtained by Khalil (1965); Hassan et al. (1977) and Shafshak et al., (1984). On the other hand, Shafshak et al. (1980), reported that soaking maize grains in GA_3 or IAA had no significant effect on the height of maize plant. While Fahmy et al. (1988), found that GA_3 and IAA at 50 and 100 ppm decreased sorghum height.

2- Ear position:

Increasing the rate of GA_3 up to the second concentration (80 ppm) significantly decreased ear height of maize plants from soil surface as compared with the other treatments (Table 3). This result did not agree with that obtained by Shafshak et al. (1984), who found that the application of GA_3 at a rate of 40 ppm produced a higher ear position.

3- Stem diameter and number of green leaves/plants:

Results in Table (3) indicate clearly that soaking maize grains in GA_3 or IAA under different concentrations significantly decreased stem diameter as well as number of green leaves/plant as compared with the control treatment. These results did not agree with those obtained by Shafshak et al., (1984). While, Shafshak et al. (1980), reported that soaking maize grains in GA_3 and IAA at 25, 50 and 100 ppm had no significant effect on stem diameter.

Table (3): Effect of some growth regulators on some growth characters of maize plants (Combined analysis of 1986 and 1987 seasons).

Treatments	Plant height (cm)	Ear height (cm)	Stem diameter (cm)	No. of green leaves/plant
Control	242.9	131.2	2.43	11.4
GA_3- 40 ppm	262.6	132.8	2.37	10.7
GA_3- 80 ppm	238.1	118.5	2.31	10.3
GA_3-120 ppm	254.9	132.8	2.37	10.9
IAA- 40 ppm	251.8	131.3	2.33	11.0
IAA- 80 ppm	245.0	129.2	2.36	10.9
IAA-120 ppm	255.3	131.2	2.37	10.4
L.S.D. at 5%	8.9	7.3	0.10	0.6

B- Effect on yield and yield components:

1- Ear length and ear diameter:

Results in Table (4) show that the growth regulator treatments did not affect significantly ear length as well as ear diameter of maize plant. Similar result was obtained by Shafshak et al., (1984). On the other hand, Cherry et al. (1960), reported that GA_3 at a rate of 200 ppm decreased ear length of maize, but Shafshak et al. (1980), found that GA_3, CCC, 2, 4-D and IAA increased ear length of maize.

2- Number of rows/ear:

Data revealed that number of rows/ear was not influenced by growth regulators used (Table 4), except only the treatment with GA_3 at 80 ppm which increased the number of rows/ear compared with 40 ppm. In general this is in agreement with the result obtained by Shafshak et al., (1984).

3- Number of grains/row:

Results in Table (4) indicate clearly that the number of grains/row decreased by soaking maize grains in solution of IAA at 40 ppm compared with 80 ppm of both IAA and GA_3. The differences between growth regulator treatments and control was not significant.

4- Number of grains/ear:

The number of grains/ear was not affected by growth regulator treatments, except only the treatment with 80 ppm of GA_3 which increased the number of grains/ear than 40 ppm of IAA. Shafshak et al. (1984), reported that GA_3 or IAA had no significant effect on number of grains/ear.

5- Ear weight and grain weight/ear:

Data in Table (4) show that soaking maize grains in different growth regulators had no significant effect on ear weight as well as grain weight/ear. This result indicates that there was no relevance between GA_3 and IAA and these characters. Similar result was obtained by Shafshak et al. (1984).

6- Number of ears/plant:

Similarly, GA_3 and IAA treatments did not affect significantly the number of ears/plant of the treated maize grains (Table 4). Shafshak et al. (1980), found that, some growth regulators significantly increased number of ears/plant of maize.

Table (4): Effect of some growth regulators on yield and yield components of maize (Combined analysis of 1986 and 1987 seasons).

Treatment / characters	Control	GA_3 ppm			IAA ppm			L.S.D. at 5%
		40 ppm	80 ppm	120 ppm	40 ppm	80 ppm	120 ppm	
Ear Length (cm)	19.90	20.20	19.8	19.80	19.8	19.9	20.3	N.S.
Ear diam. (mm)	45.10	45.70	45.7	45.30	44.6	45.5	45.8	N.S.
No. of rows per ear	12.30	12.10	12.5	12.20	12.2	12.1	12.2	0.4
No. of grains per row	42.20	42.70	43.7	43.60	41.6	44.2	42.1	2.0
No. of grains per ear	515.80	516.20	545.8	531.90	509.1	535.9	517.4	31.7
Ear weight (gm)	190.10	192.70	195.3	185.10	166.1	195.4	196.4	N.S.
Grain weight per ear (gm)	150.30	153.00	155.7	146.90	146.7	154.2	155.6	N.S.
No. of ears per plant	0.92	0.91	0.94	0.94	0.93	0.93	0.93	N.S.
Ear weight/plant (gm)	164.20	170.40	172.9	164.50	160.2	175.4	185.8	20.2
Grain weight/plant (gm)	129.90	133.10	137.8	133.90	126.2	138.5	147.1	17.1
Shelling %	78.90	78.30	79.3	79.50	78.4	78.6	79.1	N.S.
100-grain weight (gm)	33.80	34.30	33.7	31.70	33.0	34.9	34.9	2.2
Ear yield/fed (kg)	2990.80	3153.00	3253.6	3076.20	2966.3	3094.7	3220.5	N.S.
Grain yield/fed (kg)	2383.20	2472.20	2584.9	2453.30	2338.1	2470.6	2551.1	N.S.

7- Ear weight/plant and grain weight/plant:

Data presented in Table (4) show that soaking maize grains in solution of IAA at higher level (120 ppm) produced the highest weight of grains/plant. However, the lowest of IAA (40 ppm) gave the lowest grain yield/plant. These results are in harmony with those obtained by Shafshak et al. (1980) and Fahmy et al. (1988).

8- Shelling percentage:

Soaking maize grains in different concentrations of GA_3 or IAA had no significant effect on shelling percentage of maize plants. It seems that shelling percentage is mainly a genetical character showing no response to physiological effects. Similar result was obtained by Shafshak et al., (1984).

9- Weight of 100 grains:

Data obtained show that, the lowest GA_3 concentration (40 ppm) was more effective in increasing 100-grain weight. However, increasing the concentration of GA_3 up to 120 ppm decreased seed index as conpared with the other concentrations. Fahmy et al. (1988), reported that, soaking sorghum grains for 6 and 12 hours in 50 ppm of IAA, 50 and 100 ppm of GA_3 significantly increased seed index of grains.

10- Yields of ears and grain/feddan:

Data revealed that yields of ears and grain/fed. were not influenced by growth regulators used (Table 4). This result is expected since soaking grains of maize in different concentraitons of GA_3 and IAA (40, 80 and 120 ppm) showed no significant effect on ear length, ear diameter, ear weight, weigth of grains/ear as well as number of ears/plant. Similar result was obtained by Cherry et al., (1960); Rizk & El-Antably (1974) and Shafshak et al., (1984). On the other hand, Khalil (1965); Shafshak et al., (1980) and Fahmy et al. (1988), found that some growth regulators i.e. GA_3, IAA, 2, 4-D and CCC increased grain yield of sorghum and maize.

III- Correlation between grain yield and some characters of maize plant:

The association between grain yield and each of the yield components, i.e., ear length, ear diameter, number of rows/ear, number of grains/row, weight of grains/ear, shelling percentage and ear yield is presented in Table (5).

Positive correlation coefficients were obtained between yield of grain and each of ear length ($r = 0.545^{**}$) ear diameter ($r = 0.546^{**}$), number of rows/ear ($r = 0.278^{**}$), Table (5): Correlation coefficients between grain yield and some characters of maize.

Trait	Grain yield	Ear yield	Shelling %	Grain weight	No. of grains /ear	No. of grains/ row	No. of rows/ ear	Ear diameter	Ear length
Ear length	0.545**	0.548**	0.195*	0.357**	0.763**	0.755**	0.412**	0.665**	--
Ear diameter	0.546**	0.557**	0.102	0.424**	0.690**	0.620**	0.493**	--	--
No. of rows/ear	0.278**	0.277**	0.160*	0.189*	0.682**	0.358**	--	--	--
No. of grains/row	0.657**	0.652**	0.294**	0.262**	0.917**	--	--	--	--
No. of grains/ear	0.628**	0.623**	0.301**	0.272**	--	--	--	--	--
Grain weight	0.485**	0.482**	0.099	--	--	--	--	--	--
Shelling %	0.381**	0.304**	--	--	--	--	--	--	--
Ear yield	0.995**	--	--	--	--	--	--	--	--
Grain yield	--	--	--	--	--	--	--	--	--

number of grains/row (r = 0.657**) number of grains/ear (r = 0.628**), shelling percentage (r = 0.381**) and ear yield (r = 0.995**). Also, a postive and significant correlation coefficient was found between grain yield and each of ear length as shown by Moursi et al., 1975; number of rows/ear (Nigem, 1976); number of grains/row (Ibrahim, 1977; Mahgoub, 1979 and Gouda, 1982) and number of grains/ear (Maghoub, 1979 and Gouda, 1982).

It could be concluded that, yield of ear, number of grains/row, number of grains/ear, ear diameter and ear length were the major components of maize seed yield, since they showed highly significantly correlation as follows, 0.995, 0.657, 0.628, 0.546 and 0.545, respectively.

IV- Effect of the interaction:

The effect of the interaction between maize varieties and growth regulator (GA_3 and IAA) treatments on all studied characters was not significant. Such result indicates that each experimental factors acted separately.

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