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EFFECTS OF ETHYLENE APPLICATIONS ON THE PHYSIOLOGICAL RESPONSE, GROWTH AND YIELD COMPONENTS OF COTTON.

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ABSTRACT

Two field experiments were carried out at Sids Agricultural Research Station, Beni-Suef Governorate Middle Egypt, during 2012 and 2013 seasons to study the effect of applications ethyleneon growth, yield components, fiber properties and chemical constituents of the Egyptian cotton hybrid [G83 (G75 X G5844)] X G80 (*Gossypiumbarbadense L.,*). Cotton plants were treated with ethylene at start or at maximum of flowering. The experimental design was a randomized complete blocks with four replications.Results obtained could be summarized as follows:

- The application of ethylene 20 ppm. at peak of floweringincreased significantly, no. of open bolls/plant, boll weight, seed cotton yield/fed., earliness % and lint % in two seasons.
- When ethylene applied at both stages, no. fruiting branches/plant and seed indexwere insignificantly affected.
- On the other hand, spraying cotton plants with ethylene at 20 ppm at peak of floweringtended to increase micronaire reading while fiber strength was not affected in both seasons.
- Application of ethylene at 20 ppm at peak of floweringtended to increase chemical contents in cotton leaves i.e. chlorophyll a, total chlorophyll, carotene, total soluble sugar and polyphenols.

It could be concluded that spraying ethylene 20 ppm. at peak of flowering could be recommended production of this new cotton hybrid [G83 (G75 X G5844)] X G80 under Middle Egypt location .

Keywords: Cotton, Hybrid, Ethylene,Physiology,Growth, Yield Components, Fiber.

INTRODUCTION

Ethylene can be produced by almost all parts of higher plants, although the rate of production depends on the type of the tissue and the stage of development. However, ethylene production also increases during leaf abscission and flower senescence, as well as during fruit ripening. Ethylene was discovered in commotion with its effects on seedling growth and fruit ripening. It has since been shown to regulate a wide range of responses in plants, including seed germination, cell expansion, cell differentiation, flowering, senescence and abscissionCampilloand Lewis (1992).Ethylene is widely regarded as a growth inhibitor and has long been thought to provide a signal leading to senescence and early aging in plants rearrangeAbeles *et al.* (1992).Sawan*et al.* (1984) and Abdel-Al *et al.* (1987) found that spraying ethrel after planting led to increase the no. of open bolls, lint% and seed cotton yield/plant, especially concentrations of 5 and 10 ppm. The effect of ethylene on chemical components was studied by some investigators. The activity of chitinase increases in cotton leaves in response

to ethylene Boller*et al.*(1983). WhileAbdel-Al *et al.* (1987),Bondoket *al.* (1994)andKassem and Namich (2003)found that spraying cotton plant with ethrelincrease chemical characters.Thus, application of ethephonincrease the concentration of ethylene inside bolls, ethylene stimulates cellulase and other hydrolase enzymes which weaken and dissolve cell walls (Abeles,1969).Jones (1968) showed that ethylene enhanced the apparent activity of α-amylase by aleuronic cells when gibberellic acid was present, but the effect of ethylene was only to enhance the release of the enzyme from the tissue.Kawakami *et al.* (2010) reported that there was no significant effect on water-use efficiency and dry matter production water-stressed cotton plants treated with 1-Methylcyclopropene (1-MCP), but individual leaves had higher stomatal resistance and better maintenance of membrane integrity.Lokaand Oosterhuis (2011) reported that application of 1 Methylcyclopropene (1-MCP) to water-stressed cotton plants, carbohydrate metabolism of the pistil was significantly affected.

The present work was aimed to study the beneficial effect of ethylene on growth, yield and some chemical components when applied at start and maximum of flowering.

MATERIALS AND METHODS

Two field experiments were carried out at Sids Agricultural Research Station, Beni-Suef Governorate Middle Egypt,during 2012 and 2013 seasons to study the physiological effect of ethylene (2-Chloroethyl Phosphoric Acid) on the Egyptian cotton hybrid [G83 (G75 X G5844)] X G80 (*Gossypiumbarbadense L.,*). Characters this cotton hybrid areshown in Table (1).

Table 1. Main characters the new cotton hybrid [G83 (G75 X G5844)] X G80.

Hybrid name	New cotton hybrid.
Species	barbadense.
Category	Long staple
Pedigree	Crossing between [G83 (G75 X G5844)] X G80.
Characteristics	Long staple characterized by high yielding, early maturity, high lint %, resistance to fuzariam and tolerance to relatively high temperature (Middle Egypt).
Botanical distinguishing characters	The main stem has strong growth. The leaves are medium size, green color; five deep lobes and it have one gland in lower midrib. Compact intermediate. The node of the first fruiting branch ranged from 6-7. The flower is tubular shape with yellow petals a dark purple spot on the petals base and yellow pollen grains. The boll is conically shape with three loculi and sometimes four. Seed is of medium size with little fuzz covers. Fuzz color is brown.
Hybrid bred by	Breeding Res Section, Cotton Res., Agric. Res. Center, Giza, Egypt.

The experimental unit included 5 ridges (4 m long and 60 cm apart) occupying an area of 12 m². Cotton seeds were planted in the last week of March in the two seasons. Distance between hills was 25 cmleaving two plants/hill at thinning time. The experimental design was a randomized complete blocks design with four replicates, where the following seven treatments were evaluated:

1) Control spraying tap water.
2) Spraying ethylene 10 ppm. atstart of flowering.
3) Spraying ethylene 20 ppm atstart of flowering.
4) Spraying ethylene 10 ppm atpeak of flowering.
5) Spraying ethylene 20 ppm atpeak of flowering.
6) Spraying ethylene 10 ppm at start of flowering + 10 ppm atpeak of flowering.
7) Spraying ethylene 20 ppm at start of flowering + 20 ppm atpeak of flowering.

Phosphorus fertilizer as ordinary superphosphate (15.5% P_2O_5) at the rate of 22.5 kg P_2O_5/fed.was incorporated during seed bed preparation. Nitrogen fertilizer in the form of ammonium nitrate (33.5% N) at the rate of 60 kg N /fed. was applied in two equal doses, immediately before the first and the second irrigations. Potassium fertilizer in the form of potassium sulphate (48% K_2O) at the rate of 24 kg K_2O/fed.was side-dressed in a single dose before the second irrigation. Standard agricultural practices were followed throughout the growing seasons.

The chemical analyses of traits were carried out through both seasons which were:Sample of the upper fourth leaves were collected as 15 days after spraying to determine leaves content of chlorophyll a, total chlorophyll Arnon (1949), carotenoids Rolbelen (1957), total soluble sugars Cerning (1975), poly phenols Simons and Ross (1971).

Plants of five representative hills were taken at random from each plot to study the following traits: No. of fruiting branches/plant, no. of open bolls/plant,boll weight (gm), lint % and seed index (gm).

The seed cotton yield (ken./fed.) was estimated as the weight of seed cotton yield (kilogram) picked twice from the three central rows of each plot, then converted to yield/fedden in kentar (Kentar = 157.5 kg.). Earliness index was determined as percent of seed cotton yield at first pick to total seed cotton yield/plot.

Fiber tests (pressley index and micronaire reading) were performed at the laboratories of the Cotton Technology Research Division, Cotton Research Institute, Agricultural Research Center, Giza, Egypt, according to A.S.T.M. (1975).

Data were subjected to statistical analysis as proposed by Snedecor and Cochran (1981) and means were compared by LSD at 5% level of probability.

RESULTS AND DISCUSSION

Yield and yield components:

The results in Table (2) show that the application of ethylene to cotton plants exerted a signification effect on no. of open bolls/plant, boll weight and cotton seed yield/fed. in 2012 and 2013 seasons, respectively.The highest values of no. of open bolls/plant (27.0 and 23.7) was obtained from spraying ethylene 20 ppm at peak of flowering while the lowest values (19.0 and 19.1) were obtained from without spraying treatment (control), in 2012 and 2013 seasons, respectively.

The highest value of boll weight (2.51 and 2.53 g.) were obtained from spraying ethylene 20 ppm at peak of flowering, while the lowest values (2.36 and 2.35 g.) were obtained from without spraying treatment (control) in both seasons.

Table 2: Effect of ethylene treatments on growth characters, yield and its components during 2012 and 2013 seasons.

Treatments of ethylene spraying	No. of fruiting branches /plant		No. of open bolls/plant		Boll weight (g)		Seed index		Seed cotton yield (ken./fed.)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1- Control.	15.0	14.0	19.0	19.1	2.36	2.35	9.08	8.91	9.35	8.13
2- 10 ppm at start of flowering.	15.3	14.3	22.1	20.3	2.41	2.40	9.12	9.10	9.97	8.63
3- 20 ppm at start of flowering.	16.2	15.5	23.7	21.8	2.45	2.39	9.23	9.15	10.21	9.10
4- 10 ppm at peak of flowering.	16.0	14.5	23.1	20.7	2.43	2.38	9.17	9.14	10.10	8.70
5- 20 ppm at peak of flowering.	17.9	16.0	27.0	23.7	2.51	2.53	9.32	9.23	10.58	9.43
6- 10 ppm at start + 10 ppm at peak of flowering.	17.0	15.8	25.1	22.5	2.46	2.49	9.26	9.16	10.49	9.13
7- 20 ppm at start + 20 ppm at peak of flowering.	15.43	14.2	20.7	19.8	2.40	2.36	9.11	8.93	9.53	8.59
L.S.D. at 5%	N.S	N.S	2.80	2.40	0.08	0.05	N.S	N.S	0.35	0.66

Spraying ethylene 20 ppm at peak of flowering significantly increased seed cotton yield/fed. which amounted to 10.58 and 9.43 ken./fed. increased by (13.2 and 15.9%), as compared to without spraying treatment(control) which yielded 9.35 and 8.13 ken./fed. in 2012 and 2013 seasons, respectively. While no. of fruiting branches/plant and seed index were not significantly affected by such treatmentsin the two seasons. In general, the results revealed that ethylene application to cotton plants tended to increase no. of open bolls/plants as compared to the control in both seasons.

The data in Table (3) revealed that earliness percentage was significantly affected by ethylene treatment in both seasons. Spraying ethylene 20 ppm at peak of flowering, significantly increased earliness percentage (75.9 and 74.2) during 2012 and 2013 seasons respectively,

compared with without spraying treatment (control). This increase may be due to ethylene is well known as plant hormone characterized by its effect on fruit ripening. Also, ethylene treatment increased lint percentage as a result of increasing the rate of dehiscence of bolls. The increase in lint percentage as a result of ethylene treatment agreed with those obtained by Sawan*et al.* (1984).

Fiber properties:

The results of fiber quality as shown in Table (3) indicate that ethylene treatments increased micronaire value in 2012 and 2013 seasons, respectively.The highest micronaire value (4.4 and 4.4) was obtained from spraying ethylene 20 ppm at peak of flowering while the lowest values (4.0 and 4.4) were obtained from without spraying treatment (control), in both seasons. These results are agreement with **Abdel-Al *et al.* (1987).**

Table 3: Effect of ethylene treatments on earliness %, lint % and fiber properties during 2012 and 2013 seasons.

Treatments of ethylene spraying	Earliness (%)		Lint (%)		Micronaire Reading		Pressley index	
	2012	2013	2012	2013	2012	2013	2012	2013
1- Control.	72.2	70.7	41.2	39.6	4.0	4.0	10.2	10.0
2-10 ppm at start of flowering.	73.1	71.7	42.3	40.5	4.1	4.0	10.3	10.2
3-20 ppm at start of flowering.	74.2	73.1	41.6	40.8	4.3	4.2	10.7	10.6
4-10 ppm at peak of flowering.	73.5	72.5	41.3	40.6	4.3	4.2	10.6	10.6
5-20 ppm at peak of flowering.	75.9	74.2	43.0	41.7	4.4	4.4	11.3	11.2
6-10 ppm at start + 10 ppm at peak of flowering.	74.8	73.7	42.1	41.1	4.4	4.3	11.2	10.9
7-20 ppm at start + 20 ppm at peak of flowering.	72.9	71.6	41.3	40.3	4.2	4.1	10.3	10.2
L.S.D. at 5%	0.26	0.98	0.33	0.29	0.22	0.20	N.S	N.S

The data revealed that ethylene treatments had no significant influence on fiber strength in both seasons. It is clear from these data that pressley index values were almost similar in all treatments. Thus the foliar spray of ethylene to cotton plants failed to cause any improvement in fiber strength. These data are in contrast with those obtained by Sawan*et al.* (1984) who concluded that spraying cotton plants with ethrel especially with a concentration of 5 or 10 ppm increased bundle strength, while micronaire value was higher.

Chemical constituents:

It is clear from the results in Table (4) and Figure (1 and 2) that all chemical constituents i.e., chloroplast pigments, carbohydrates and phenols content of cotton leaves were significantly affected by ethylene treatments and the effect depends on chemical type, ethylene concentration as well as the time of application.

A. Photosynthetic pigments:

Results presented in Table (4) and Figure (1 and 2) revealed that leaves content of chlorophyll a, total chlorophylls and carotenoids were significantly influenced by application of ethylene. Values of such pigments tended to increase as concentration of ethylene increased.

Table 4: Effect of ethylene on some chemical constituentsin during 2012 and 2013 seasons.

Treatments of ethylene spraying	Chloroplast pigments (mg/g)				Carotenoids (mg/g dry wt.)		total soluble sugars (mg/gm dry wt.)		Poly phenols (mg/gm dry wt.)	
	Chl. A		Total Chl.							
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
1- Control.	4.17	4.07	7.39	7.22	0.42	0.36	15.62	15.10	12.75	12.60
2- 10 ppm at start of flowering.	4.45	4.36	7.84	7.62	0.57	0.48	16.37	16.23	13.26	13.10
3- 20 ppm at start of flowering.	4.57	4.48	8.14	7.84	0.70	0.65	17.23	17.05	13.83	13.65
4- 10 ppm at peak of flowering.	4.51	4.42	7.98	7.74	0.66	0.57	16.92	16.70	13.40	13.15
5- 20 ppm at peak of flowering.	4.75	4.66	8.47	8.19	0.90	0.74	18.75	18.66	15.10	15.00
6- 10 ppm at start + 10 ppm at peak of flowering.	4.67	4.56	8.32	8.02	0.83	0.64	18.33	18.10	14.75	14.55
7- 20 ppm at start + 20 ppm at peak of flowering.	4.32	4.23	7.65	7.42	0.52	0.43	16.07	15.45	13.13	13.08
L.S.D. at 5%	0.08	0.06	0.11	0.05	0.06	0.05	0.29	0.18	0.23	0.08

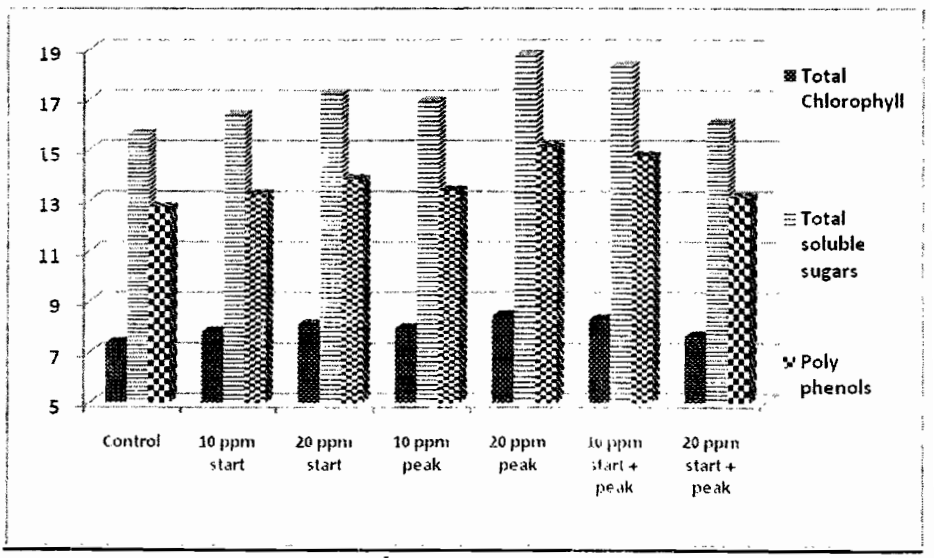

Figure1:Some chemical constituents as affected by ethylene treatments during 2012 season.

B. Carbohydrates:

Data presented in Table (4) and Figure (1 and 2) showed that in comparison with the control, all ethylene concentrations exhibit significant increase in leaves content of total soluble sugars. Increasing carbohydrate level in cotton leaves treated with ethylene appears to be a secondary result of decreasing the translocation of carbohydrate from the source leaf toward the stem apex Abeles *et al.*, (1992). Several reports showed that ethephone increased cotton leaves content of sugars Abdel-Al *et al.* (1987),Bondok*et al.* (1994) and Kassem and Namich (2003).

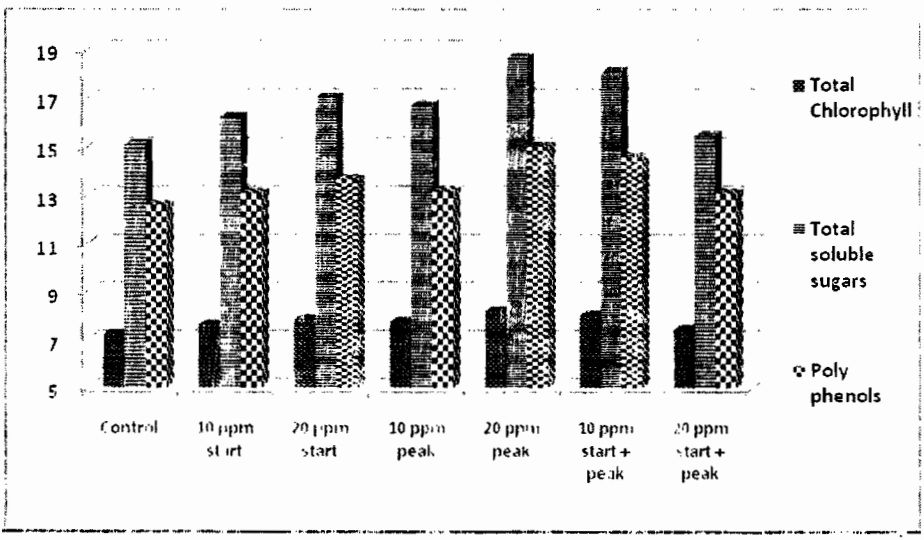

Figure2:Some chemical constituents as affected by ethylene treatments during 2013 season.

Also, the increase in total soluble sugars in treated plants was clearer when ethylene was applied at peak of flowering than start of flowering, when compared to the control This means that ethylene when applied at the concentration of 20 ppm stimulates and enhances the photosynthetic activity and increases the metabolites required for more carbohydrate biosynthesis. This also may be due to the indirect effect of ethylene on enzyme activity in cell organs.

C. Phenols:

The data in Table (4) and Figure (1 and 2) revealed that phenols of cotton leaves were generally higher in plants treated with ethylene especially when it was applied at maximum of flowering, where the increase was more pronounced in treated plants as compared to the control. This means that ethylene stimulate the synthesis of more compounds leading to the formation of phenols The maximum values of phenols were attained from plants treated with 20 ppm of ethylene at the maximum of flowering(15.10 and

15.00 mg/gm dry wt.) during 2012 and 2013 seasons respectively, compared with without spraying treatment(control)(12.75 and 12.60 mg/gm dry wt.).

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تأثير إضافة الأثيلين علي الأستجابة الفسيولوجية والنمو ومكونات المحصول في القطن

سناء جمعة جبالي، صابر شعبان عبد الجيد ومصطفي عطية عمارة.
معهد بحوث القطن – مركز البحوث الزراعية – الجيزة – مصر.

أجريت تجربتان حقليتان بمحطة البحوث الزراعية بسدس خلال موسمي ٢٠١٢، ٢٠١٣ لدراسة تأثير الرش بالأثيلين بمعدلين ١٠، ٢٠ جزء في المليون وذلك عند مرحلة بداية التزهير وعند قمة التزهير مقارنة بعدم الرش (رش بالماء)، وتأثير ذلك علي صفات النمو والمحصول ومكوناته ودلائل التبكير وصفات التيلة والصفات الكمياوية للأوراق علي هجين القطن المصري الجديدG80 X [(G75 X G5844) G83].
ويمكن تلخيص نتائج الدراسة كما يلي:

- أوضحت النتائج أن الرش بالأثيلين بالتركيز ٢٠ جزء في المليونعند قمة التزهير أدي الي زيادة معنوية في عدد اللوز المتفتح علي النبات ومتوسط وزن اللوزة والنسبة المئوية للتبكير والنسبة المئوية للشعر ومحصول القطن الزهر للفدان، كذلك قيمة الميكرونير، بينما أعطي تأثير غير معنوي علي صفاتعدد الافرع الثمرية، معامل البذرة والبريسلي.
- أدي الرش بالأثيلين رشا بالتركيز ٢٠ جزءفيالمليونعند قمة التزهير الي زيادة معنوية في محتوي الأوراق من كلورفيل أ ومحتوها من الكلورفيل الكلي والكاروتين وايضا هناك زيادة معنوية في السكريات الكلية والفينولات.
- أظهرت النتائج المتحصل عليها أن أفضل المعاملات كانت الرش بالإثيلين بتركيز ٢٠ جزء في المليون عند قمة التزهير.

قام بتحكيم البحث

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